ERRATA

PART TWO - CHAPTER II - SUBREGION "A"

Pg. I-5, Par. 10, 4th line: Delete <u>of the region</u> and insert <u>in Maine</u>.

Pg. IV-2, Table 9, 4th line: 2nd column, change <u>58.8</u> to <u>52.5</u>; 2nd column, change <u>0.179</u> to <u>0.160</u>; 3rd column, change <u>Jan. 1948</u> to <u>Sept. 1941</u>.

Pg. IV-8, 1st line: Change <u>IX</u> to <u>X</u>.

Pg. IV-19, Par. 44, 6th line: Change <u>27,500</u> to <u>30,000</u>.

Pg. IV-25, Par. 51, Item 1, 1st line: Change <u>37</u> to <u>41</u> and change <u>(27,500)</u> to <u>(30,000)</u>.

Pg. V-12, Par. 20, 7th line: Change <u>seven</u> to <u>six</u>.

Pg. VIII-9, Par. 16, 5th line: Change <u>17</u> to <u>19</u>.

Pg. VIII-9, Par. 17, last line on page: Change <u>$1,659,700</u> to <u>$1,744,700</u>.

Pg. VIII-10, 1st line: Change <u>$47,500</u> to <u>$54,000</u>.

Pg. X-2, Par. 3, 5th line: Insert <u>and</u> between <u>Park</u> and <u>on</u>.

Pg. XII-3, Table 43, 6th item: Change <u>1938</u> to <u>1948</u>.

Pg. XII-4, Par. 8, 5th line: Change <u>no</u> to <u>little</u>.

Pg. XII-12, Par. 27, 3rd line: Insert <u>and Franklin County in</u> between <u>County</u> and <u>Maine</u>.

Pg. XIV-12, first line: Change <u>$1,222,500</u> to <u>$1,307,500</u>.

Pg. XIV-14, last line: Change <u>6</u> to <u>46</u>.

Pg. XIV-21, Par. 22, 7th line: Change <u>$1,659,700</u> to <u>$1,744,700</u>.

FOREWORD

This book contains one chapter of Part Two of the Report of the New England-New York Inter-Agency Committee, organized by direction of the President of the United States for the purpose of making a comprehensive survey of the land, water and related resources of the New England-New York Region.

The complete report comprises three parts:

Part One - The General Report.

Part Two - The Technical Report, with detailed studies of the river basins and special subjects.

Part Three - Reference Data.

THE RESOURCES

OF THE

NEW ENGLAND-NEW YORK REGION

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Part Two

SUBREGION "A"

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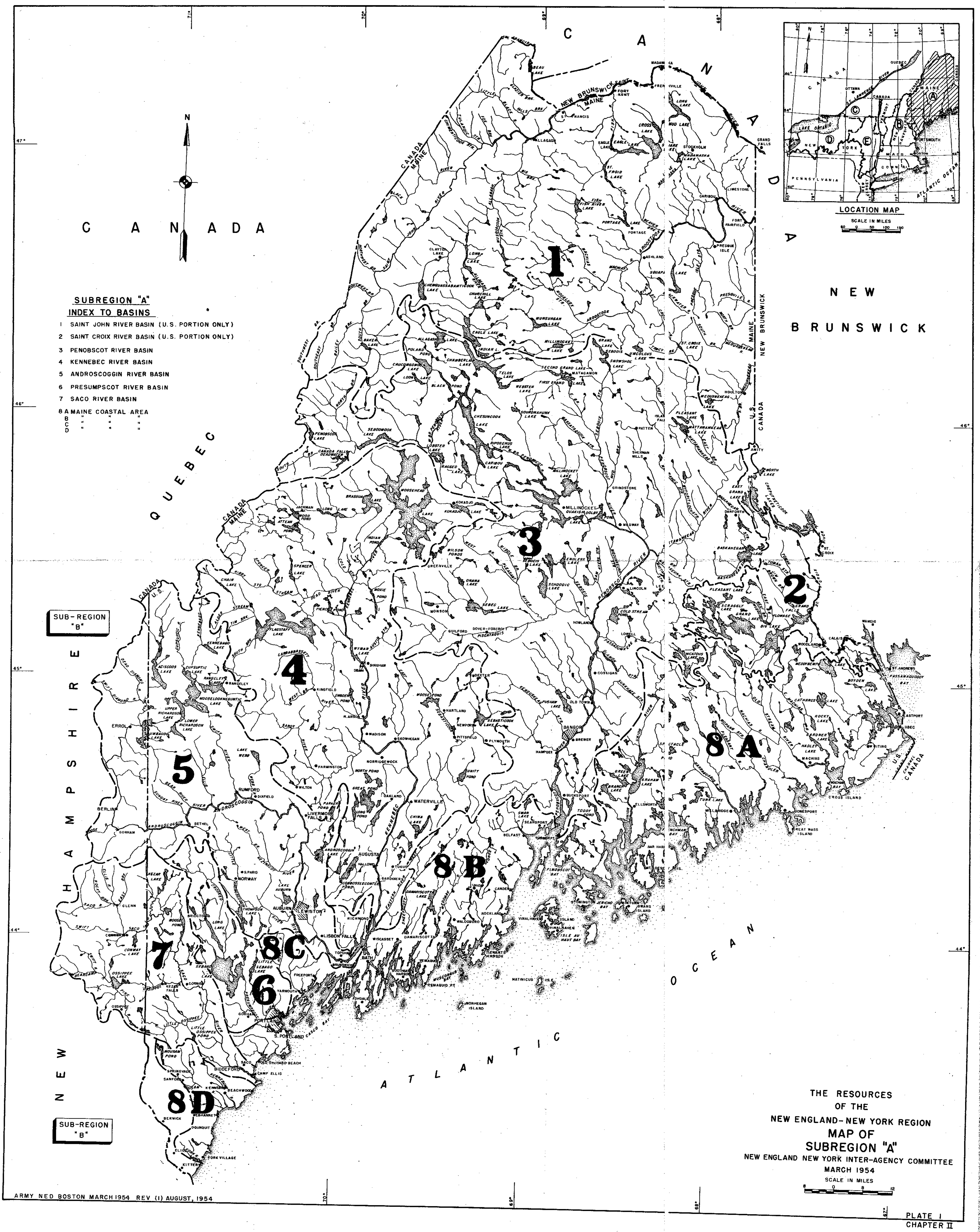
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PART TWO

CHAPTER II

SUBREGION "A"

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SECTION I - GENERAL DESCRIPTION

LOCATION AND AREA

1. For convenience in making the survey of resources the designation Subregion "A" was adopted by the Committee for that portion of the New England-New York Region lying to the north and east of the Merrimack, Connecticut and Piscataqua River Basins. It includes all of the State of Maine with the exception of 247 square miles along the southwestern boundary, which is in the Piscataqua River Basin; and in addition contains some 1,600 square miles of eastern New Hampshire in the headwater drainage of the Saco and Androscoggin River Basins. The total area of the subregion is 33,594 square miles which is approximately one half of the area of the New England States.

SURFACE WATERS

2. Major rivers. - There are five major river systems within Subregion "A", which together drain four-fifths of the area of the whole subregion. These river systems in order of size are the Penobscot, which drains 8,570 square miles; the Saint John, with an area of 7,360 square miles in the United States portion of the basin; the Kennebec, draining 5,870 square miles; the Androscoggin, draining 3,450 square miles; and the Saco, 1,697 square miles. The remainder of the subregional area is made up of the St. Croix Basin having an area of 1,010 square miles in the United States; the Presumpscot Basin, 648 square miles, and the Maine Coastal Area of some 5,999 square miles. Of the major

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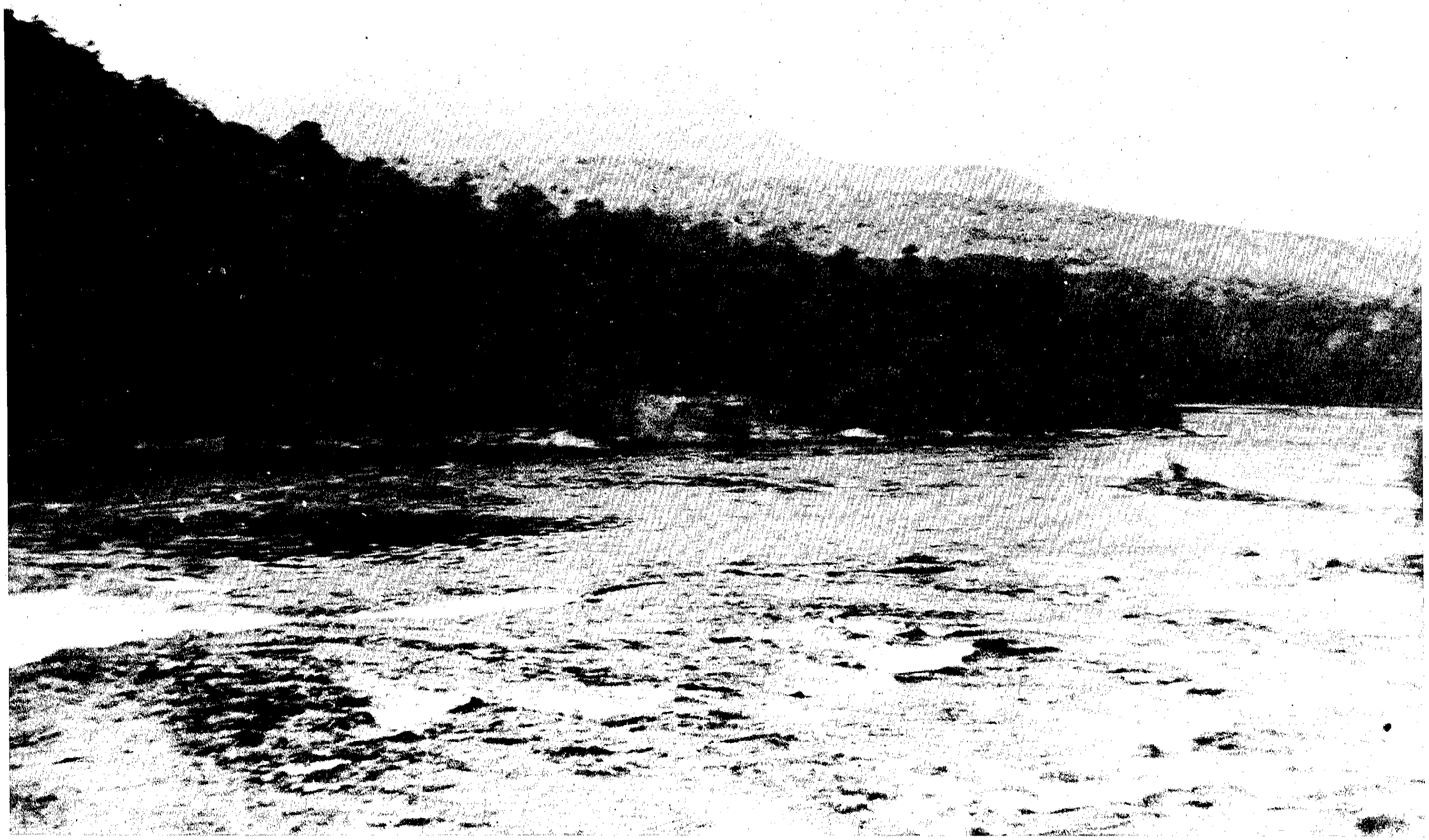
rivers, all but the Saco have large headwater lakes, and all five have sizeable lakes in their tributary systems. These rivers follow irregular courses but the net direction of their flow reflects the general slope within the portion of the subregion which each occupies. The Saint John River flows in a general northerly and northeasterly direction before swinging around to a southeasterly course. The Penobscot and Kennebec Rivers follow generally southerly courses; and the Androscoggin and Saco Rivers flow in a general southeasterly direction. Major deflections such as the great bends in the Androscoggin and Kennebec Rivers reflect a degree of bedrock control on river flow, but the irregular courses of the tributaries and their haphazard arrangement in the system in large measure, reflect surface irregularities created by continental glaciation.

3. Lakes. - Lakes and ponds of a great variety of sizes and shapes are found in the naturally and artificially dammed depressions throughout the subregion. Many of these water bodies originated as glaciers receded leaving a highly altered surface. Surface water bodies are especially numerous in that portion of the subregion which lies to the east of the main Penobscot River. The larger lakes in this group include Grand Lake, Big Lake and Meddybemps Lake.

4. In the central portion of the subregion are Moosehead Lake, the largest lake in the subregion, Chesunticook, Chamberlain and Millinocket Lakes, all of which have artificially raised levels.



Mountain and forest terrain. Mt. Katahdin and West Branch Penobscot River, Maine. Subregion "A".

Other large lakes are to be found in the Fish River system, in the northern portion of the subregion; the Rangeley Lakes district, in the east-central portion; the Belgrade district, in the south-central portion; and the Sebago and Ossipee Lakes districts, in the southern portion of the subregion.

TOPOGRAPHY AND GENERAL GEOLOGY

5. Topography. - Subregion "A" has a long and irregular coastline measuring some 2500 miles. To the southwest of Casco Bay and Portland, there are extensive sandy beaches backed by tidal marsh land and relatively flat low-lying country. Northeast of Portland, the coastline is extremely irregular with drowned river mouths separated by long rocky promontories and fringing islands. The coastline is deeply indented by the magnificent reentrant of Penobscot Bay. To the northeast, the coastline terminates on the west shore of the international Passamaquoddy Bay at the mouth of the St. Croix River.

6. With few exceptions, the land, within ten miles of the coast, lying to the southwest of Penobscot Bay is at elevations varying up to 200 feet above mean sea level, and is predominantly low and gently rolling. Numerous land forms in this portion of the subregion bespeak glacial or aqueo-glacial activity.

7. Lowlands extend to the great bend of the Kennebec River Valley, and into the central Penobscot Basin to the confluence of the Mattawamkeag River and Penobscot River. To the northeast of

Penobscot Bay, the lowland is at first confined to the immediate coast, but extends some 20 miles inland to the north of Mount Desert Island. It is again constricted north of Frenchman's Bay and becomes an expanse some 20 miles wide between Frenchman's Bay and the St. Croix River.

8. Inland from the coastal lowland, the land rises gradually into gently undulating to rolling upland. This upland extends as a gradually expanding belt averaging some sixty miles in width from the southern subregional boundary northeastward through the central portions of the Kennebec and Penobscot River Basins, and then spreads eastward to the St. Croix River and northward through the Aroostook portion of the Saint John Basin. The general elevation of the rolling upland is between 200 and 1000 feet above mean sea level. This upland is broken into four segments by the valleys of the Saco, Androscoggin, Kennebec and Penobscot Rivers. Along the inland margin of the rolling upland southwest of the Penobscot River, elevation increases are fairly rapid. The increase in general elevation becomes marked between this portion of the upland and the subregional divide culminating in the White Mountains. This change to higher elevations is not regular, however, as the valleys of the Kennebec and Androscoggin Rivers and the intervening mountain range contribute sharp relief. Many summits in the White Mountain groups and in the range which extends into Maine on the east side of the upper Androscoggin Valley stand above 3500 feet.

The highest mountains in this portion of the subregion are Mount Washington (6288 feet mean sea level), Mount Franklin (5028 feet m.s.l.), Mount Hancock (4430 feet m.s.l.) and Mount Jackson (4012 feet m.s.l.) in New Hampshire and Sugarloaf Mountain (4237 feet m.s.l.) in Maine. This mountainous area is the source of the headwaters of three of the five major rivers of the subregion, the Saco, Androscoggin and Kennebec.

9. Between the main stem of the Penobscot River and the Aroostook River, the general slope of the land is toward the south with a gradual decrease in elevation from about 500 feet to 200 feet mean sea level. The rolling surface of this portion of the subregion is dotted with numerous lakes and poorly drained depressions. In the Aroostook area the land slopes gradually toward the southeast from elevations near 1000 feet to less than 500 feet on the United States-Canada boundary.

10. The Penobscot or central lake area is surmounted by the Katahdin Mountain system with summit elevations commonly over 4000 feet. Baxter Peak, with an elevation of 5267 feet, is the highest in Maine ~~of the region.~~ The land falls away sharply to the east and northeast of Katahdin and more gradually to the west and northwest. The remainder of the subregion from the Moosehead Lake area, through the Upper Saint John River Basin, is a rough, forested upland at elevations between 1000 and 2000 feet. Elevations of over 2000 feet occur on the major drainage divides, and elevations of less than 1000 feet occur in the valleys of the Saint John River system.

11. Bedrock geology. - The bedrock in that portion of the subregion to the south and west of the Kennebec River is a complex of Cambrian to Carboniferous gneisses and schists. The regional trend of these schists and gneisses is northeast-southwest and they are intruded by granitic to dioritic igneous rocks of Carboniferous or earlier age. Granite outcrops are widespread in an interrupted and irregular band about 20 miles in width from Casco Bay northward to the subregion boundary west of Jackman, Maine. In the coastal lowlands southwest of Portland, there are slates, phyllites, and quartzites of Paleozoic age. Early Paleozoic slates, sandstones, and limestones, more widely exposed to the northeast, outcrop in the central and northern portion of the Kennebec River Valley. These rocks are intruded by early Paleozoic granites, rhyolites, and diabases, the latter now altered to epidote-chlorite schists.

12. East and northeast of the Kennebec River Valley the bedrock is composed chiefly of early Paleozoic slates, shales, sandstones, quartzites, and lesser amounts of limestone in northeasterly trending anticlines and synclines. Devonian sedimentary rocks outcrop mainly in two belts. The first belt trends northeastward through Moosehead Lake and Chesuncook Lake to Presque Isle, and the second belt, lying to the north of the first, trends northeastward through Chamberlain Lake to the Fish River Lakes. Within this area of Devonian rocks and flanking, earlier Paleozoic sedimentary rocks, outcrops of rhyolite, rhyolitic tuff and breccia, and meta-diabase are common.

13. On the coast from Casco Bay to Eastport, a strip about 40 miles in width is underlain by Paleozoic metamorphic and igneous rocks. In the vicinity of Machias Bay and Passamaquoddy Bay Paleozoic sedimentary rocks and volcanic rocks outcrop extensively. In the Mt. Desert Island-Penobscot Bay region rhyolitic tuff and breccia and meta-diabase are abundant. From the coast northward to the belt of Devonian rocks, intrusions of granite, possibly of Devonian age, are widespread.

14. Surficial geology. - The present topography, though primarily controlled by bedrock structure, has been molded by erosion and deposition resulting from continental glaciation. All but the steepest slopes are mantled, to some degree, by unsorted materials, or till, which were transported, altered and deposited by the glaciers. The steep slopes were scraped and plucked bare of weathered materials by this glaciation. The mantle of till has subsequently been covered in many areas by outwash and such land forms as kames, kame terraces, deltas and eskers stand above it. Kame terraces and eskers or "horsebacks" are characteristic features in the Kennebec and Penobscot River Basins and the eastern part of the Saint John and St. Croix. An extensive mantle of glacial outwash occurs in the portion of the basin southwest of Portland and much of this has been reworked by marine action in the lower valleys and redeposited as marine clays which now extend many miles inland. Some areas of clay were subsequently covered by

marine sands. North of Casco Bay outwash is again extensive but the marine deposits are confined to the lower valleys and the inland penetration is not deep.

15. Forests. - There are three natural forest regions in Subregion "A". These are the spruce-fir region, the white pine-transitional hardwoods region and the northern hardwoods region. The spruce-fir region extends from the northwestern boundary of the subregion through the Upper Androscoggin, Kennebec, Penobscot and Saint John River Basins. The white pine-transitional hardwoods region, which includes white pine, red pine, birch, beech, maple and hemlock, and some oaks in the southern portion, occupies most of the remainder of the subregion to the southwest of the Penobscot River. The northern hardwoods region is represented in the Aroostook area and in an intermediate zone extending from the St. Croix Lakes through the central Penobscot Basin and into the Kennebec River Basin. The spruce-fir region appears again in the northeast portion of the subregion in the vicinity of the St. Croix River and extends southwestward along the coast to the vicinity of Casco Bay. About 90 percent of the subregion is covered by woodlands and forests in various stages of growth. All of the forested lands, except those on the higher mountain slopes and in the remote northwestern portion of the subregion, have been cut over at some time in the past.

16. Soils. - The soils of Subregion "A" belong to two forest soil groups - the Podzol and Brown-Podzolic. The Podzols occupy a

zone where coniferous trees predominate, extending through the higher upland and highland portions of the subregion from Ossipee Lake to the Aroostook area. These are largely rough stony leached soils having shallow development. They are generally acid, with poorly decomposed surface accumulations of organic material. Podzols also extend to the coast in the northeastern area of the subregion. The Brown-Podzolic soils occupy much of the remainder of the subregion. These soils have generally developed under mixed needleleaf-broadleaf forests and usually are deeper, less acid, and more naturally fertile than the Podzols. The majority of soils of both the Podzol and Brown-Podzolic groups have formed in glacial till derived from acid granites, gneisses, schists, slates and quartzites. In the Aroostook area the soils have, in many cases, developed in till which was derived from a parent material containing lime. Alluvial soils are found in the river flood plains, and poorly drained or bog soils are found in the poorly drained depressions throughout the subregion. These poorly drained soils are extensive in the west central portion of the Penobscot Basin. In the coastal areas in the lower valleys of the major rivers which discharge into the ocean along the Maine Coast, soils have formed in marine clays and sands. The natural fertility of the Brown-Podzolics is fairly high, but it can be easily exhausted by improper agricultural management.

MAPS

17. About 85 percent of Subregion "A" is covered by U. S. Geological Survey topographic maps with a scale not less than 1:63,360, or one inch equals one mile, leaving about 5500 square miles in northwestern Maine, or roughly 15 percent of the State, unmapped. Topographic maps that are not of standard quality cover about 20 percent of the subregion. Work planned, authorized or in progress by the Topographic Division of the Geological Survey will cover nearly 30 percent of the deficient area with maps of standard quality. This will leave about five percent of the subregion with substandard topographic coverage.

18. Published and unpublished geologic maps cover 10 percent of the area of the subregion. These maps are roughly rectangular in shape, are drawn to a scale not smaller than 1:62,500, or about one inch equals one mile, and show the general geology, i.e., all rock units, of the area that can be mapped. There are other geologic maps of irregular shape, small scale, and limited or incomplete coverage. Published geologic maps cover only two percent of the subregion. Bedrock geology is shown on these maps with the exception of the Rockland and Eastport folios, where both bedrock and surficial geology have been mapped. Unpublished geologic maps cover about eight percent of the subregion. Both bedrock and surficial geology have been mapped in nine fifteen-minute quadrangles, bedrock geology alone in five, and surficial alone in one. Included in the

category of unpublished mapping are areas where field mapping is in progress, areas on which reports are being written or maps are being drafted, and areas for which a map and/or report are in the process of publication.

CLIMATE AND HYDROLOGY

19. Climate. - Subregion "A" has a stimulating climate with four fairly well-defined seasons. The position of the subregion in the extreme east portion of the continent; the fact of its southward to southeastward facing coast, not backed by highlands; the extensive highlands and uplands along its western border; plus a latitudinal position between 43° and 47° N. in the mid-latitude westerly wind belt are major determinants of the climate. The subregion is in a zone which comes under the influence of contrasting and conflicting air-masses and the mid-latitude cyclonic systems moving from the west and south in response to the position of these air-masses and upper air movement. Average temperature ranges from warmest to coldest month of over 56°F in the northern portion and of about 40°F in the zone of partial marine influence, near the coast, reflect a high degree of continentality. However, because the unobstructed exposure along the coast permits the southerly and easterly winds associated with mid-latitude cyclone systems, to sweep in off the ocean, precipitation is fairly evenly distributed throughout the four seasons of the year. Therefore it is unlike that of similar latitudes in the interior of the continent where the amount of cold season precipitation is noticeably less than that of the summer.

20. Precipitation. - Precipitation in Subregion "A" averages from 46 inches along the coast to about 34 inches in the Aroostook area with as much as 50 inches coming to the northeast coastal area. Most of the subregion receives between 38 and 42 inches of precipitation during the year, with substantially larger amounts in the mountainous portions. Storms producing warm season rains are generally more intense and of shorter duration than are those of the winter months. Winter precipitation is largely in the form of snow, and annual snowfall averages from 55 inches near the southern coast to over 190 inches in the White Mountains, some 60 miles to the west. From south to north through the subregion the snowfall averages from 70 to 100 inches. Snow cover varies from an average of 60 days near the coast to over 120 days in the higher western and northern portions of the subregion. The depth and the prolonged duration of the snow cover on the eastern slopes of the White Mountains permit a long season of recreational skiing, and account for the high run-off contribution of this area to stream flow during the spring.

21. Temperatures. - Summer temperatures along the whole coastal area are several degrees cooler than are the temperatures in the inland portion. The average July temperatures along the coast range from 68°F in the southern portion to 62°F along the northeast portion and offer respite for vacationists from hot and humid areas. Inland temperatures range between 68°F and 70°F from the western

boundary of the subregion northeastward to the central Penobscot Basin. To the north and east of the Penobscot Basin average July temperatures range between 64°F and 68°F. Mid-day temperatures during the summer months are comfortably warm along the coast, but are seldom hot because of the sea breeze. The winter temperatures show definite response to the 4 degree latitudinal change, and the temperature gradient from the coast through the northern portions is fairly steep. Average January temperatures along the coast are between 24°F and 26°F and drop to below 10°F in the extreme northern portions of the subregion. The growing season generally lasts from 180 days in the southern coastal portion to less than 110 days in the northwestern and northern portions of the subregion. The climatic conditions throughout the subregion are excellently suited to the growth of forests and grasses.

22. Hydrology. - The annual run-off throughout the subregion is being measured at 52 stream gaging stations some of which have been operating since the beginning of this century. By 1950 a total of 1500 station years of records were available, all of which are published in annual reports of the U. S. Geological Survey entitled "Surface Water Supply of the United States, Part I, North Atlantic Slope Basins." Average annual run-off varies from a low of 14 inches in the west-central part of the area to a high of 50 inches in the White Mountains with an average over the area of about 21 inches. The annual run-off throughout the subregion

averages from 50 percent of the annual precipitation in the southern coastal areas to 60 percent of the annual precipitation in the northern portions of the subregion. In general, only in the coastal basins does the runoff occur fairly evenly throughout the year. In the southern interior section of the subregion roughly 40 percent of the yearly runoff takes place during the months of March through May. In the central inland portions of the subregion as much as 40 percent of the runoff occurs during April and May and in the northern portions of the subregion as much as two-thirds of the annual runoff occurs during the months of April through June. Substantial and dependable surface water sources exist throughout the subregion, and ground water supplies are generally available to vegetation and to dug or driven wells. Occasionally, short droughty periods in the late summer cause embarrassment to owners of shallow wells, and grasses become yellow and withered from lack of water. When the rains come, however, the wells fill rapidly and the grasses recover with vigor.

23. Because of the wide variation of streamflow from basin to basin throughout the area, the task of determining yield of drainage basins is continuous. Information is seriously deficient on the yield of small streams on which data are needed especially for the study of water supplies for small communities, farm ponds and irrigation and the design of highway culverts and bridges. The installation of additional gaging stations on ungaged streams of importance and on representative small streams would cost an estimated $33,000.

SECTION II - ECONOMIC DEVELOPMENT

BACKGROUND

1. Early settlements. - The first attempts to establish formal settlements in the area embraced in Sub-region "A" prior to 1610, failed due to early conflicts between the French and English interests and claims. Colonization in what is now the State of Maine was slow for many years, though fishing and fur trading continued to develop along the coast and scattered settlements were appearing elsewhere throughout the region. Early relations between the settlers and the Indians were relatively peaceful, but the outbreak of King Philip's War in Southern New England in 1675 was quickly followed by hostilities to the north and east. From this time until the end of Lovewell's War in 1725 the history of the settlements along the coast was largely one of war with the local tribes, who were usually supported by the French. It was not until after the expulsion of the French from Canada in 1760 that settlers pushed any great distance into the interior. Between 1760 and the outbreak of the American Revolution, shipbuilding and overseas trade developed rapidly, lumbermen began to cut timber in the forests accessible from the coast and prosperous communities began to appear. The War of the American Revolution all but ended expansion, but settlement was quickly resumed after the Revolution and the population increased from 96,540 in 1790 to 228,705 in 1810.

2. Industries. - Economically, the sub-region has been dominated by a few major industries. Prior to the Civil War, Maine was the leading shipbuilding state in the Union, and shipbuilding remained important for another half century. Ships were built at fifty towns and cities on the coast of Maine, but at the present time, the City of Bath is the only remaining site of major shipbuilding. During this same period, the lumber business was growing through the exploitation of the vast forests of the sub-region. The best timber had been taken from the coastal section by the time of the American Revolution and the lumbermen then penetrated the interior for timber, using the river valleys as avenues. The headwater area of the Penobscot became the heart of the lumber industry during its most prosperous days. At the turn of the century the pulp paper industry was introduced. In 1903 the Great Northern Paper Company took over the rights and facilities of the Penobscot Log Driving Company, marking a basic shift in the industrial evolution of the State of Maine from long timber production to the smaller cutting required for pulp.

3. The textile industry, introduced into New England after the American Revolution, became firmly established in Maine after experimental ventures at Brunswick in 1809 and elsewhere in succeeding years. Until well into the 20th century, cotton

textile manufacture was the State's leading industry, in terms of capital invested. Woolen manufacture followed cotton, and both remain highly important in the present day economy.

4. <u>Fishing.</u> - Fishing, which early brought Europeans in numbers to the coasts of Maine, continued to be a major activity, but emphasis gradually shifted from deep-sea fishing to the off-shore exploitation of herring, lobsters, and shellfish. The canning of small herring, or sardines, gives employment to many workers.

5. <u>Mineral industries.</u> - The quarrying and burning of limestone for plaster, cement and soil conditioners began as early as 1733 in the coastal region about Waldoboro and Thomastown. The cement plant at Thomastown of the Dragon Cement Company -- the only cement plant in New England -- and the nearby limestone quarries and processing works are important. Maine was formerly one of the largest producers of granite, but with the decline of the use of this material for paving, production of granite has become of minor importance. Scattered pegmatite deposits 1/ are still productive.

1/ Pegmatite is a coarse grained rock composed essentially of quartz, feldspar and mica in various proportions. Feldspar and its co-products, mica and beryl, are at present the most important products of pegmatite mining.

6. <u>Ice.</u> - For several decades, before the widespread use of mechanical refrigeration, the Kennebec and Penobscot Rivers were the scene of an important industry in the cutting and shipping of natural ice to southern cities and the tropical countries as far away as India.

7. <u>Use of rivers.</u> - Closely integrated in time and economic association with the production of wood pulp paper came the development of electric power. The dams, many of which were built a century and more ago to facilitate the Spring drive of long logs, now aid in bringing down short pulpwood sticks to the great paper mills at Millinocket and elsewhere, or furnish head for hydro-electric power generators.

8. <u>Agriculture.</u> - Farming followed lumbering up the river valleys, reaching its peak in extent and number of farms before 1880. The production of general farm produce has been followed by specialization in poultry, dairy products, potatoes, and crops for canning, such as peas.

9. <u>Recreation.</u> - The picturesque coastal strip, cool, easily accessible, and rich in 300 years of stirring history; and the eastern ranges of the White Mountains began to attract summer visitors in the 19th century. The subregion has become one of the most famous resort areas in the country, with both summer and winter recreational attractions.

ECONOMY

10. The economic development of Subregion "A" has followed a pattern which is generally recognized as being typical in advancing economies. In the early days, reliance on the primary industries 1/ was heavy. The importance of these gradually diminished as the secondary industries 2/ assumed larger roles in the area's economy. Increased activity in the secondary industries brought with it a demand on the part of business for more and more services, such as transportation, communication, finance, and repair services. Increased incomes, derived primarily from employment in the secondary industries, led to larger demands for the various forms of personal services and to an increasing volume of retail and wholesale trade. As a result of stimuli from these two sources, the tertiary industries 3/ grew in importance. Thus, there has now come about a situation in the area where the secondary and tertiary industries dominate the economic scene and where the primary industries play a lesser, although significant, part. While statistics for a longer period of time would give a better picture of the development of this trend, figures for the years 1910-1950, as presented in Table 1, give some indication of what has been happening.

1/ Primary industries - agriculture, forestry and fishing.
2/ Secondary industries - manufacturing, mining and construction.
3/ Tertiary industries - distribution, services, clerical, transportation, communication, education, recreation and government.

Table 1 - Labor force by general divisions of occupations in the State of Maine, Subregion "A"
(Percentages are of total labor force)

Occupational grouping	1910	1920	1930	1940	1950
Primary industries	26.9%	25.9%	19.6%	17.7%	10.6%
Secondary industries	38.4	35.8	37.4	36.2	40.7
Tertiary industries	34.7	38.6	42.9	46.1	48.7

Source: Figures from 1910-1940 are from Federal Reserve Bank of Boston, Monthly Review, March 1947. Figures for 1950 are from U.S. Census of Population for 1950. Figures for different years may not be strictly comparable because of different statistical methods used.

NOTE: Statistics are given for the State of Maine which accounts for almost all of Subregion "A". Addition of data for that part of New Hampshire included in the subregion would not significantly alter the general picture.

11. The important role which the secondary industries play in the region's economy should be emphasized. Not only are these industries important for their own sake, but a good portion of the activity in the tertiary industries depends, either directly or indirectly, on the level of activity in the secondary industries. A slump in manufacturing, for example, would mean a lesser demand for such things as transportation, distribution, finance, and the like. It would also mean reduced employment and thus lower incomes for individuals; this would adversely affect the demand for various types of personal services. Manufacturing is by far

the most important of the secondary industries group. It is also Maine's most important single source of employment. It accounts for 85% of the workers in the secondary industries and almost 35% of the entire labor force of the State. It employs more than twice as many workers as the next largest single category, wholesale and retail trade. Manufacturing is also the most important single source of income payments to individuals, as the data in Table 2 demonstrate.

Table 2 - Income payments to individuals by major components in the State of Maine (1929,1948,1952), Subregion "A" (Percentages are of total income payments)

	1929	1948	1952
Agricultural income	10.3%	10.2%	5.6%
Manufacturing payrolls	20.1	26.5	27.9
Trade and service income	23.3	24.5	23.0
Government income payments	8.1	15.2	18.4
All other	38.2	23.6	25.1

Besides emphasizing the importance of manufacturing in the area's economy, these figures provide further evidence concerning the basic trends mentioned above.

MANUFACTURING

12. Manufacturing, the subregion's most important economic activity, is concentrated in a relatively small number of industries. In 1952 five industries accounted for 83% of the total value of

product turned out and 77% of all workers employed in manufacturing. 1/ These five industries, together with the value of product and the percentages of total value of product and workers employed, are listed in Table 3.

Table 3 - Manufacturing activity in the State of Maine for the year 1952, Subregion "A"

Type of Industry	Value of Product	Percentages of Value of Product	Percentages of No. of Workers
Textile mill products	$ 273,420,706	24%	19%
Paper and allied products	248,097,179	22	12
Leather and leather products	146,782,775	13	16
Food and kindred products	145,619,368	13	14
Lumber and wood products	127,240,886	11	16
TOTALS	$ 941,160,914	83%	77%

Source: Census of Maine Manufactures, 1952 - Maine Department of Labor and Industry

13. The downward trend which has been characteristic of the textile industry in New England in recent years is well known, so that the large extent to which the subregion relies on it is not an encouraging factor. Both production and employment in textile mills in Maine declined between 1951 and 1952, and the presumption seems to be that the decline will continue in the future. While this is a general development which affects the entire area, its impact on particular communities is especially severe.

1/ Figures are for Maine. In that part of New Hampshire included in the subregion the paper and allied products industry is the most important type of manufacturing activity.

14. The leather and leather products industry (primarily footwear) is another whose status in New England is far from certain. While there have recently been gains in both production and employment in the industry in Maine, much of this has come as a result of the removal of operations from parts of southern New England. This is an industry which is more prone to jumping about from place to place than are most other types of businesses. Certain features peculiar to the industry give it a higher than average mobility. There is no assurance that the industry will continue to expand (or even remain stable) within the subregion. Relatively small changes in factors crucial to the industry could cause many firms to cease their operations and move to other areas.

15. Thus, two of the subregion's most important industries (accounting in 1952 for 37% of the value of all manufactured products and 35% of all workers employed in manufacturing in Maine) are in that group whose future in New England is uncertain. The instability which arises from this situation needs to be considered in any thinking about the area's future. If efforts to stabilize the textile and footwear industries are unsuccessful, gaps left by their declines must be compensated for by expansions in other fields.

16. The other three of the subregion's five most important manufacturing industries seem to be on firmer footing. Both the

paper and allied products industry and the lumber and wood products industry have a firm materials base in the area and can reasonably be expected to continue substantial operations here. Much of the production in the food and kindred products industry is for a localized market. There is also considerable processing and packaging of a variety of seafoods which are distributed nationally. That part of the industry which produces frozen fried fish sticks has been expanding rapidly of late. Sales of fish sticks are presently increasing at a faster rate than those of any other item in the frozen foods line, and executives in the industry believe that substantial growth possibilities are still present. There is also a growing market for frozen French fried potatoes, green peas, squash and beans. A large quantity of dressed poultry is shipped to New York.

17. After the first five discussed above, the next most important manufacturing industry in the subregion is that producing transportation equipment. Most of the activity in this line is concentrated in shipbuilding. Next in importance (as measured by value of product) come the non-electrical machinery industry, the fabricated metal products industry, printing, publishing, and allied industries, the apparel and allied products industry, and the chemical and allied products industry. An especially important characteristic common to the apparel, printing, chemical, fabricated metal products, and

transportation equipment industries has been the growth which they have displayed in recent years. From them, as well as from some industries which are now of minor importance in the area (furniture, electrical machinery, and rubber products, for example) may come the expansion which will take up some of the slack caused by declines in other lines of activity, especially in textiles.

18. Manufacturing activity is concentrated primarily in the southern and western parts of the subregion. The northern and eastern sections have relatively little manufacturing in them. In terms of product value, the ten most important manufacturing cities (or towns) in Maine in 1952 were, in order: Portland, Lewiston, Sanford, Biddeford, Bath, Auburn, Millinocket, Augusta, Cumberland, and Waterville. Of these, only Millinocket, a papermaking center, is in the northern part of the State; all the others are in the southwestern part. When the locational density of manufacturing workers in the State is plotted on a map, the Lewiston-Auburn area is seen to be the approximate geographic center of Maine's manufacturing population. 1/ Berlin, New Hampshire, of course, is relatively close to the industrialized portion of Maine.

1/ Census of Maine Manufactures, 1952, p. VII.

PRIMARY INDUSTRY

19. Subregion "A" has a larger percentage of the population engaged in the primary occupations than does most of the rest of New England, although even here the percentage is not large and has been steadily decreasing. In Maine the three most important agricultural products are potatoes, poultry, and dairy products. In 1952, the potato crop was worth almost $86 million, poultry production almost $63 million, and dairy products about $39 million. Taken together these three accounted for about 88% of the State's cash receipts from farm marketings. Aroostook County has long been one of the nation's most important centers of potato production. In recent years, both the price of potatoes and the income derived from potato production have fluctuated widely. Prices and incomes in 1951 were considerably lower than in 1952. Although the final figures for 1953 are not available, they are expected to be the lowest in many years. This instability has led the farmers of Aroostook County to increasingly try new types of crops in order to diversify the county's agriculture and help to stabilize it. The poultry industry has expanded rapidly in Maine in recent years until the chicken now rivals the potato as the State's most important agricultural product. Timber is Maine's most abundant natural resource, about 85% of the land area of the State being forested. While employment in actual forestry pursuits themselves is not

large, these resources form the basis for the State's important paper and lumber industries. Fishing provides employment for about 5,000 Maine workers -- less than 2 percent of the total labor force. This source of employment, however, is very important in certain coastal towns and villages.

TERTIARY INDUSTRY

20. The tertiary industries have steadily increased in importance down through the years, as is true in most advancing economies. These are industries whose level of activity depends largely upon what happens in other fields. The demand for various types of services and the course of retail and wholesale trade depend primarily upon how much money the population has to spend and upon how business in general, especially manufacturing, is going. Although for the most part the tertiary industries in the subregion follow a typical pattern, recreational activities, particularly the vacation part, deserve special attention. The recreation business is an important source of income to both Maine and New Hampshire. While exact figures on both the income and employment arising from this industry are difficult to determine, it is certain that the dollar volume of income and the number of jobs are substantial. Many related types of concernes --

retail stores, service stations, transportation companies, for example -- also receive a large amount of business as a result of the spending done by vacationists.

21. There is considerable feeling that the potentialities of the recreation business in the area have not as yet been fully exploited. More adequate facilities, better roads, increased publicity, and more research into the wants and habits of the vacationist have all been suggested as approaches to the problem of attracting more business. The industry also has its internal problems. One of the most important of these arises because of the short duration of the New England Summer vacation season. More determined efforts are needed to lengthen the season and so enhance its revenue-producing ability. The summer season traditionally begins about the Fourth of July and lasts until Labor Day. If substantial members of people could be induced to being their vacations earlier, or to stay past Labor Day, or both, the summer vacation trade would make a more substantial contribution and to the area's economy. Another difficulty stems from the age and condition of many of the existing resort facilities in the area. Many are old, in a poor state of repair, and lack the modern facilities which present-day travellers demand. Greater attention to the modernization and

repair of existing structures, as well as to the erection of new facilities, would be desirable. In short, action along several lines holds out the possibility that the subregion's income from the Summer vacation business could be increased substantially.

22. Hunting and fishing are also sources of considerable revenue for the region. Hunters and fishermen, both from within the subregion and from outside, spend heavily for such things as licenses, equipment, guiding services and sporting camp accomodations. In many parts of the subregion conditions are ideal for hunting and fishing. It is felt by those actively concerned with this field that more attention devoted to publicizing the attractions of the area for the outdoor sportsman would pay dividends in the form of an increased volume of business.

23. Winter vacations also play a role in the recreational picture, particularly in that part of the region located in New Hampshire. The increased popularity of skiing has been largely responsible for the greater number of winter vacations, a factor which makes this business highly sensitive to the vagaries of the weather. An encouraging sign of late, however, has been the increased amount of winter patronage reported by establishments outside the skiing areas. This may mean that non-skiing winter vacations in New England are becoming more popular.

FACTORS INFLUENCING ECONOMIC DEVELOPMENT

24. The economic development of any area is, of course, conditioned by the resources which that area possesses. In the case of subregion "A" several factors have been important in shaping its development. The situation in respect to the area's primary and tertiary industries was discussed above. As regards the all-important category of manufacturing, several things which have been of particular importance should be mentioned.

25. Natural resources and raw materials. - The subregion is liberally endowed with timber. There is generally enough sand and gravel available to meet local construction needs. Stone, suitable for cutting and crushing, is plentiful. Large deposits of limestone provide raw materials for New England's only cement plant and large limestone processing works. Aroostook County has large deposits of manganese for which a usable recovery process has been earnestly sought and which now appears probable if not certain of attainment. The pyrrhotite deposit at Katahdin Iron Works is one of the large proven sulfur and iron reserves of the country to be called upon when higher grade sources are exhausted. Feldspar and strategic mica and beryl, obtained from the pegmatite deposits of western Maine, are relatively unimportant in peace time, but become important in time of war. Maine has large reserves of high quality peat. The production is small, but the product commands a high price compared to materials obtainable

elsewhere. Deposits of copper are located in both Maine and New Hampshire, although none of them have been worked for many years. Most of the materials used in the area -- especially the industrially essential ones like coal, petroleum, iron ore, and the like -- must be brought in from outside. The necessity for doing this frequently puts the area's manufacturers at a disadvantage when compared with their competitors in other parts of the country. Added transportation costs place an extra burden on the manufacturer here. One apparent advantage of the subregion which has not been fully exploited is its favorable location with respect to foreign sources of supply of raw materials. The excellent harbors of Portland and Searsport are closer to many foreign countries than are most other ports on the Atlantic seaboard and Gulf coast, although this geographical nearness is not reflected in the present pattern of ocean freight rates. As United States reliance on foreign sources of raw materials increases in the future, as it appears almost certain will be the case, the subregion's favorable location with respect to these materials can be a factor enhancing its competitive position.

26. Human resources. - In the eyes of most manufacturers, the human resources of the subregion constitute one of the area's strongest points. The 1950 population of Subregion "A" is

estimated as 926,300. Of the total, 31,000 are in the New Hampshire portion of the Androscoggin and Saco River Basins, and 895,300 in Maine. About 49 percent of the subregion's inhabitants live in 30 cities and towns of over 5,000 population. Table 4 lists the principal cities.

Table 4 - Cities and towns with populations over 10,000, Subregion "A"

City or town	State	Population (Census of 1950)
Portland	Maine	77,634
Lewiston	Maine	40,974
Bangor	Maine	31,558
Auburn	Maine	23,134
South Portland	Maine	21,866
Augusta	Maine	20,913
Biddeford	Maine	20,836
Waterville	Maine	18,287
Berlin	New Hampshire	16,550
Sanford	Maine	15,177
Westbrook	Maine	12,284
Brunswick	Maine	10,996
Bath	Maine	10,644
Saco	Maine	10,324

Except for Berlin, New Hampshire these cities, which contain almost 38 percent of the population of the subregion, are all in the southern half of the subregion and within 45 miles of the sea coast. There are vast areas of northern Maine and large areas in eastern Maine which are virtually uninhabited.

27. The subregion has an adequate labor force, one that has had experience with industrial processes and which is noted for its more than average stability. Wage rates are generally lower than in the rest of New England, and labor-management

relations on the whole have been good. Most manufacturers regard the availability and character of the labor force as being one of the area's strongest competitive advantages. Statistics on the population and labor force of the State of Maine in 1950 are presented in Tables 5 and 6. That part of New Hampshire included in the subregion would add an estimated 30,800 to the population and 11,900 to the labor force. Forecasts of the future population and labor force are given in Table 7.

Table 5 - Population of Maine, by Counties - 1950
Subregion "A"

	Total	Per Square Mile
The State	913,774 1/	29.4
Androscoggin	83,594	174.9
Aroostook	96,039	14.1
Cumberland	169,201	192.1
Franklin	20,682	12.0
Hancock	32,105	20.8
Kennebec	83,881	97.0
Knox	28,121	77.7
Lincoln	18,004	39.4
Oxford	44,221	21.2
Penobscot	108,198	31.7
Piscataquis	18,617	4.7
Sagadahoc	20,911	81.4
Somerset	39,785	10.1
Waldo	21,687	29.5
Washington	35,187	13.8
York	93,541 1/	93.5

Source: U.S. Census of Population, 1950

1/ Includes approximately 18,500 persons residing in Subregion "B".

Table 6 - Experienced labor force by detailed occupation, State of Maine - 1950, Subregion "A"

Total, 14 years and over	342,010
Professional, technical and kindred workers	24,159
Farmers and farm managers	17,011
Managers, officials and proprietors, except farm	27,620
Clerical and kindred workers	30,334
Sales workers	22,158
Craftsmen, foremen and kindred workers	45,166
Operatives and kindred workers	86,734
Private household workers	7,544
Service workers, except private household	21,349
Farm laborers and foremen	12,334
Laborers, except farm and mine	38,088
Occupation not reported	9,513

Source: U.S. Census of Population, 1950

Table 7 - Forecast of population and labor force for Maine for years 1960, 1975, 2000, Subregion "A"

	Population	Labor Force
1960	991,000	374,598
1975	1,064,000	402,192
2000	1,164,000	439,992

28. A substantial portion of the population is concentrated in the southwestern part of the subregion. Much of the northeastern part is sparsely populated. Per capita income in Maine in 1951 was $1,298 and in New Hampshire it was $1,444. The national average was $1,584. It is worth noting, however, that in recent years per capita income in Maine and New Hampshire has been increasing at a faster rate than in the rest of New England.

29. <u>Location with respect to markets.</u> - Its location with respect to markets has been important in influencing the types of products which the subregion turns out. Situated, as it is, in the northeast corner of the nation, Subregion "A" is disadvantageously located in relation to a large number of the nation's major markets. This has meant that the area's manufactures have had to be products whose value is high in relation to their bulk, in order that the adverse impact of high transportation costs could be offset. This has been true except in those cases where a substantial materials base has been enough to nullify the disadvantages of distance from markets, or where production has been largely for nearby markets.

30. <u>Transportation.</u> - Transportation facilities are generally adequate or in process of being made so, the subregion's inland needs being met by a network of highways and railroads. Airline service, both passenger and freight, is also available. Facilities for water transportation are good, the harbors of Portland and Searsport being the most important. Despite the adequacy of facilities rates are high, a factor which adversely affects the competitive position of many of the area's firms. (A more complete description of transportation facilities is given in paragraphs 32 to 35.)

31. <u>Fuel, power and water.</u> - The subregion has no indigenous deposits of the important fuels. Coal and fuel oil, the major

fuels used, must be brought in from considerable distances. This results in average fuel costs which are higher than in most other parts of the United States. Supplies of fuel are adequate for industrial users, but these users suffer from the higher costs of the fuels purchased. The supply of power is ordinarily sufficient to meet all demands; conditions which in the past sometimes caused temporary shortages have been corrected for the most part. Costs of this power are high or low, depending on what the basis of comparison is. When compared with most of the rest of New England, power costs in the subregion are low. However, in relation to some other parts of the United States, they are relatively high. Since part of the power supply is generated by steam, there is some relationship between fuel costs and power rates. The area's water supply is good, both in respect to providing water for power generation and for processing purposes. The availability of water is important for the production of such things as chemicals, pulp, and paper, and in the mining industry. For each ton of ore at least five tons of water are required in the mining concentration and refining processes.

TRANSPORTATION

32. Roads. - The major population centers in the river valleys and coastal areas of the subregion are served by numerous highways. U.S. Route 1 follows the coastline from Kittery to

Calais and on northward to Presque Isle and Fort Kent. From the southern tip of the subregion to Portland this route is paralleled by the Maine Turnpike Toll Road. The inland area is crossed by U.S. Route 2 from Gorham, New Hampshire to Houlton, Maine and the southern portion of the subregion is served by a network of highways. U.S. Route 201, from Augusta to Jackman, is an important through route to Quebec, Canada. The upper Saint John River basin and the Upper Penobscot River basin in the northern part of the subregion, and the upper Machias basin east of Old Town, Maine, have few roads and access to these areas is severely limited.

33. Railroads. - The Boston and Maine Railroad from Boston to Conway, New Hampshire and Portland, Maine and the Maine Central from Portland to Brunswick, Augusta, Waterville, Bangor, Ellsworth and Calais, Maine, serve the principal centers on the coast and in the major river valleys. The Rockland Branch of the Maine Central from Brunswick to Bath, Wiscasset and Rockland, Maine serves one of the most picturesque areas in the subregion. The inland populated areas are served by the Canadian National Railways on a line from Montreal to Berlin, New Hampshire and Portland, Maine; the Maine Central feeder lines along the Androscoggin and Kennebec Rivers; the Canadian Pacific's main line from Montreal to St. John, New Brunswick, which crosses Maine below Moosehead Lake; and the Bangor and Aroostook Railroad serving eastern Maine northward to Presque Isle and Fort Kent.

34. Airlines. - Northeast Airlines provides scheduled flights from Boston, Massachusetts to Portland, Auburn, Augusta, Waterville, Bangor, Houlton and Presque Isle; and in the Summer to Rockland and Bar Harbor. These and other cities are served by eight non-scheduled freight and passenger airlines. Virtually all parts of the subregion are accessible by planes equipped with pontoons which can land on the many lakes. Many sportsmen travel to the northern hunting and fishing areas by private and charter plane.

35. Other facilities. - Ocean transportation facilities are very good, the harbors of Portland and Searsport being the most important. Portland Harbor is the most northerly deep water port of importance on the Atlantic coast of the United States. Bus and truck transportation are important in the economy of the subregion.

PROSPECTS AND POTENTIALITIES

36. The resources, for the most part, are being and it is assumed will continue to be privately developed. Extensive use of resources, by either the State or the United States Government, is not assumed, except insofar as they are used for conventionally expected public services. This must be kept in mind.

37. No economy uses its resources in any perfect or ideal way. New processes are constantly being devised, new ways of organizing business are always a possibility and the introduction of new industries is continually expected. 1/ All this affords opportunity, but opportunity used by private persons or businesses with their own private funds. State officials, economists and others might point out economic possibilities, but the investor must take the risk of failure or success. If the shoe industry is mobile and uncertain, it is because private persons may enter or leave or move the factories on a private determination of cost factors or profit possibilities. This is true of the textile industry. No community wants an industry to leave with the dire economic consequences, but in a free enterprise economy the industry must be profitable. The movement of the textile industry away from the subregion obviously places upon management the necessity to search for more profitable markets or greater efficiency if management is to stay. The most obvious way of cutting costs -- decreasing wages -- might temporarily save a few plants, but cutting income to workers does not provide an expanding economy.

1/ It has been reported that a new low cost process for extracting manganese from the low grade manganese ore of Aroostook County has been developed. There is insufficient information concerning this process, but it is considered important to note the possibilities involved.

38. While searching for new industries such as chemicals, electronics and machine tools, since these are expanding in New England, it must not be forgotten that progress in those areas already strong need not be overlooked: paper, lumbering, woodworking, food, and recreation.

39. One potential, used rather sparingly, is that of industrial and economic research. Much more use of the public universities and the other colleges is possible and a small investment in personnel and facilities for research can bring large results. There is great need for accurate economic data, widely distributed. A public very much aware of economic possibilities is essential, as is accurate information to prospective investors in opportunities. There is a vast untouched field for economic surveys and research in this subregion. There are, of course, agencies such as the Maine Development Credit Corporation and local Industrial Development Corporations, as well as the Maine Development Commission, that make known economic opportunities or promote the entrance of new industries, but economic analysis of a subregion also requires economic research. One example of the possibilities of economic analysis is the work being done by the Maine Department of Labor and Industries Division of Research and Statistics.

40. In the event of large scale war, it is clear that deposits of manganese may become of great significance and the same is true of power resources. But in this event higher prices or subsidy would be required, particularly for use of low grade minerals, barring the discovery of efficient and profitable ways to extract low grade ore.

SECTION III - STORAGE AND STREAM FLOW REGULATION

1. Introduction. - Existing major water storage in Subregion "A" amounts to about 4,900,000 acre-feet. Most of this storage is used to regulate stream flow for power purposes, but some of it is maintained for public water supply, recreation and other uses. An additional 4,400,000 acre-feet of useful storage could be developed in conjunction with additional hydroelectric power development.

2. Existing storage. - The existing storage in the river basins of the subregion ranges in amount from slightly over 92,000 acre-feet in the Saco River Basin to over 1,500,000 acre-feet in the Penobscot River Basin. Together, the Penobscot and Kennebec River Basins contain about three-fifths of the storage in the subregion. The existing storage, by river basins, is shown in Table 8.

3. Potential storage. - The principal areas of potential storage are in the basins of the Saint John and Penobscot Rivers, which together account for three-fourths of the total subregional potential. However, useful storage could be developed in the basins of the Androscoggin, Kennebec, Saco, and Machias (Coastal) Rivers. The potential storage by river basins is shown in Table 8.

Table 8 - Existing and potential useful storage, Subregion "A"

Basin	Existing storage (acre-feet)	Potential storage (acre-feet)
SAINT JOHN		
Saint John River		1,460,000
Aroostook River	81,700	535,000
Fish River		304,000
Total for Saint John	81,700	2,299,000
ST. CROIX		
St. Croix River above Vanceboro	302,000	
St. Croix River below Vanceboro	290,400	
Total for St. Croix	592,400	
PENOBSCOT		
West Branch Penobscot River	1,308,500	
East Branch Penobscot River	146,900	428,100
Piscataquis River	114,600	57,400
Mattawakeag River		863,000
Total for Penobscot	1,570,000	1,348,500
KENNEBEC		
Kennebec River above Bingham 1/	1,138,200	217,070
Sebasticook River	53,800	
Messalonskie Stream	71,800	
Sandy River		100,000
Total for Kennebec	1,263,800	317,070

1/ Moosehead Lake 545,000

Table 8 (Continued)

Basin	Existing storage (acre-feet)	Potential storage (acre-feet)
ANDROSCOGGIN		
Androscoggin River above Berlin	660,500	182,700
Lower Androscoggin River	25,300	
Little Androscoggin River	26,200	
Lake Auburn	13,300	
Total for Androscoggin	725,300	182,700
PRESUMPSCOT		
Sebago Lake	222,600	
Other rivers	62,800	
Total for Presumpscot	285,400	
SACO		
Saco River	40,480	275,000
Ossipee River	36,710	
Little Ossipee River	13,360	
Other tributaries	2,140	
Total for Saco	92,690	275,000
MAINE COASTAL		
Union River	183,660	
East Machias River	42,850	
Machias River	22,900	
Other	44,150	
Total for Maine Coastal	293,560	
Total	4,904,850	4,422,270

SECTION IV - WATER SUPPLY

1. This section includes a summary of the inventories of the quantity, quality and present water supply uses of surface and ground waters, estimates of future water supply needs, and the availability of water to satisfy future water supply requirements. A discussion is presented of the effects of pollution on the quality of surface waters, the availability of ground water, the recreational use of public water supply reservoirs, and the effects of an increase in supplemental irrigation.

SURFACE WATER AVAILABLE

2. Safe yields. - The minimum monthly flows for the period October 1929 to September 1949 were determined for each stream from gaging records of the U. S. Geological Survey where available and used as the safe water supply yield. These flows which are shown in the various individual basin chapters covering Subregion "A", were taken from gaging station records and were estimated for ungaged areas by comparison with gaged areas. Run-off patterns developed through the operation of gaging stations on small tributaries for short duration as described in Section I, would be helpful in establishing the safe yield for water supply purposes.

3. Including the international section of the Saint John River, Subregion "A" has 5,250 miles of streams with safe yields in excess of one million gallons per day as indicated below.

Safe yield in million gallons per day	Miles of streams in Subregion "A"
Over 100	725
10-100	1,222
1-10	3,303
	5,250

4. The minimum monthly flows of the principal rivers in Subregion "A" are given in Table 9, along with the dates of their occurrence.

Table 9 - Minimum monthly flows of the principal rivers in Subregion "A" October 1929 to September 1949

River	Minimum Monthly Flow Million Gallons/day	Million Gallons/day/ square mile	Date
Androscoggin River at Merrymeeting Bay, Maine	1,370	0.395	June 1948
Little Androscoggin River at Auburn, Maine	58.8	0.179	Jan. 1948
Penobscot River at Turner Point off Castine, Maine	2,460	0.287	Feb. 1948
St. Croix River at Calais, Maine	392	0.268	Feb. 1948
Kennebec River at Port Point, Maine	1,516	0.25	Feb. 1948
Presumpscot River at Presumpscot Falls, Maine	268	0.437	Jan. 1942
Saco River off Camp Ellis, Maine	291	0.167	Aug. 1949
Ossipee River near Cornish, Maine	94.5	0.208	Oct. 1947
Saint John River at Grand Falls Dam in Canada	744	0.09	Feb. 1948
Aroostook River at Washburn, Maine	65.3	0.04	Feb. 1948

5. Many miles of streams have yields less than one million gallons per day. Some of these could provide sufficient water for public water supply for a number of the smaller communities. Larger water supplies could be taken from the 5,250 miles of streams having yields greater than one million gallons per day and many lakes in the subregion.

6. Natural water quality. - The surface waters of Subregion "A" are generally suitable for domestic, agricultural, and industrial uses. They are generally soft, with a hardness of less than 50 parts per million except in portions of the Saint John River Basin, near Presque Isle, Fort Fairfield, and Limestone, Maine, where a hardness of over 100 parts per million may occur. The surface waters have a low to moderate mineral content, 16 to 152 parts per million. The higher mineral contents are found in the Penobscot and Saint John River Basin. The maxima are 84 and 152 parts per million, respectively. Corrosive waters may be encountered in a number of locations throughout the subregion and especially in the Penobscot River Basin area. The surface waters of the Kennebec, Penobscot and Androscoggin River Basins may contain sufficient color to require removal for sensitive industrial processes. Table 10 gives the minimum, median, and maximum values for selected physical and chemical analyses of 89 untreated surface waters in the subregion and also gives values for analyses of the Portland, Old Town and Caribou, Maine public water supplies.

Table 10 - Chemical and physical characteristics of untreated surface water supplies, Subregion "A" - February 1954

	89 Surface Water Supplies Median	89 Surface Water Supplies Minimum	89 Surface Water Supplies Maximum	Sebago Lake (Portland, Me.)	Old Town, Me. Water District	Caribou, Me. Water Works
	(in parts per million)					
Color	12	0	100	10	30	5
pH 1/	6.6	5.0	9.0	6.7	6.2	6.6
Turbidity	0	0	40	0	5	0
Iron	0.14	0	2.45	Trace	0.10	0.1420
Calcium (Ca)	4.1	0.87	29.8	3.15	5.1	20.37
Magnesium (Mg)	0.80	0.00	16.1	0.620	1.05	0.960
Sodium (Na)	1.7	0.2	82.2	-	7.9	0.8
Potassium (K)	1.2	0.2	20.9	-	1.4	1.8
Carbonate (CO_3)	-	-	-	-	-	-
Bicarbonate (HCO_3)	-	-	-	-	-	-
Sulfate (SO_4)	6.0	2.0	35.1	3.94	6.1	35.12
Chloride (Cl)	2.4	0.7	18.0	1	3.0	2
Fluoride (F)	Trace	0.00	0.35	0.15	0.20	Trace
Nitrate Nitrogen	0.04	Trace	2.5	0.1	0.2	0.06
Total solids	34	16	152	21	59	98
Hardness as $CaCO_3$	20	8	156	15	23	54
Alkalinity as $CaCO_3$	10	1	113	7	13	40

1/ Not in parts per million. A measure of hydrogen-ion concentration.

7. The surface water temperature varies from maxima of 74 to 78 degrees Fahrenheit in the summer to a low of 32 degrees Fahrenheit in the winter. For half of the year the surface water is cooler than the ground water which varies from 40 degrees Fahrenheit in the northern portions to 44 degrees Fahrenheit in the southern portions of the subregion.

8. The data available on the bacteriological, chemical (including biochemical and mineral) and physical quality of waters of the rivers are adequate to define the general utility of the water. These data may be obtained from the Divisions of Sanitary Engineering of the Maine Department of Health and Welfare and the New Hampshire State Health Department. Supplemental analyses are made to meet requests for information needed by prospective water users at specific locations. In conjunction with this study, the Quality of Water Branch of the United States Geological Survey collected a limited number of surface water samples during high and low stream flows for mineral analyses.

9. Sanitary quality. - The sanitary quality of the surface waters with yields in excess of one million gallons per day and their suitability for water supply uses are summarized in Table 11.

10. Conditions I, II and III water are widely scattered throughout the subregion. Most of the 491 miles of Condition IV water is located in the Androscoggin and Kennebec River Basins.

Table 11 - Summary of known present effects of industrial and municipal pollution on stream water quality
Subregion "A"

Condition	Suitable for water supply uses	Degree of pollution	Approximate miles of streams in basin 2/
I	Suitable for all water supply uses. Use as domestic water supply may require disinfection.	None	4,365
II	Suitable for public water supply after filtration and disinfection, for practically all industrial uses 1/ without treatment, for agricultural uses and for irrigation of crops.	Not appreciable	
III	Suitable for most industrial uses 1/ without treatment and for irrigation of crops consumed after cooking.	Moderate	322
IV	Suitable for some industrial uses 1/ without treatment.	Severe	491
V	Suitable for no water supply uses.	Gross	72

1/ Quality requirements for industrial water vary widely. Condition I water may require treatment for some industrial uses. Condition IV water is used without treatment for some industries not requiring a high quality of water. As water conditions decrease from I to IV they become suitable for fewer industrial uses or become more difficult to make suitable by treatment.

2/ Miles of streams in basin having a safe yield of one million gallons per day or more. Since Section V of this report considers only those streams affected by pollution regardless of flow, these flows may not agree in the two sections.

The longest reach is 124 miles on the main stem of the Androscoggin River between Berlin, New Hampshire and Topsham, Maine. Condition V water occurs in the Penobscot and Kennebec River Basins.

11. Seven communities obtain their municipal water supplies from polluted streams. The State authorities believe that, although with present treatment all public water supplies in the subregion are considered safe, polluted sources of water supply are not desirable and should either be replaced or improved in quality. Satisfactory economic sources for public water supplies are probably within reach of all communities in the subregion.

12. One hundred eighty-seven farms, almost all located along the Androscoggin River, have reported that they were unable to use stream water for stock watering because of industrial and/or municipal pollution.

13. Available salt water. - There are unlimited quantities of salt water available along the coast for industrial purposes such as cooling and wash water.

GROUND WATER

14. Yields. - A preliminary study of the ground water resources of this subregion was made by the Ground Water Branch of the U.S. Geological Survey. From the interpretation of geological maps and from field investigations, areas of significant ground water

yield were determined and are shown on maps in Chapters III to IX. Ground water adequate to meet the needs of individual rural homes and farmsteads for domestic water, stock watering and spraying is available from bedrock or unconsolidated deposits at most places throughout the region. Frequently those supplies which have been developed have proved inadequate during dry seasons.

15. Yields from bedrock. - Most of the bedrock underlying the area has a low porosity, practically all the available ground water occurring in cracks or joints. Most bedrock wells in the area yield from 1,000 to 50,000 gallons per day. In general, wells in granite and gneiss yield less than 15,000 gallons per day, while wells in schist and slate may have higher yields. Some wells in slate reportedly yield about 50,000 gallons per day. Little information is available on yields of wells in other rock types.

16. Yields from unconsolidated deposits. - Wells in till may yield enough water for domestic or farm use, but many failures are reported during dry seasons. Areas in which till is exposed at the surface are shown in the 0-50,000 gallons per day category on the yield maps in the individual basin chapters.

17. Wells in glacial outwash deposits, which occur chiefly in the valleys, show an extreme range in yield. Where comprised of saturated gravel and sand in an area of favorable recharge,

the outwash deposits may yield more than one million gallons per day. Under less ideal conditions, outwash deposits consisting chiefly of sand or gravel generally yield from 50,000 to 1,000,000 gallons per day. Deposits containing considerable silt and clay generally yield less than 50,000 gallons per day.

18. Water quality. - The ground water of the subregion is generally harder and more highly mineralized than the surface waters. The quality of the ground water is generally suitable for domestic, industrial and agricultural uses, except where hardness, iron content, and corrosiveness may have to be controlled. The natural hardness of well waters may be as high as 225 parts per million (in some parts of the Saint John River basin), but is more likely to be less than 50 parts per million. The iron content varies widely (.07 to 3 parts per million) but generally is below the acceptable maximum of 0.3 parts per million.

19. Many wells in Aroostook County, Maine are abnormally high in nitrates and chlorides because of local contamination from fertilizer and other soluble pollutants carried into the ground water by percolation. These characteristics are not general throughout the subregion. Table 12 gives the median, minimum, and maximum values of selected physical and chemical characteristics of 66 ground water supplies and also gives values for analyses of the Cumberland Center, Monson Spring, and Washburn, Maine public water supplies. The temperature of the ground water is approximately 40°F to 44°F and varies only a few degrees during the year.

Table 12 - Chemical and physical characteristics of untreated ground water supplies, Subregion "A" - February 1954

	66 Ground water supplies			Cumberland Center Maine	Monson Spring Me. Water Co.	Washburn Me. Water Co.
	Median	Minimum	Maximum			
	(in parts per million)					
Color	2	0	38	0	0	0
pH 1/	6.7	5.3	8.7	6.9	6.8	7.5
Turbidity	0	0	10	0	5	0
Iron & Manganese	0.07	0	3.0	0.24	1.20	Trace
Calcium (Ca)	7.14	1.10	63.9	9.80	4.8	63.9
Magnesium (Mg)	1.4	0.00	13.84	1.80	1.6	13.8
Sodium (Na)	3.7	0.7	24.7	-	3.7	5.1
Potassium (K)	1.7	0.4	9.20	-	1.4	1.5
Carbonate (CO_3)	-	-	-	-	-	-
Bicarbonate (HCO_3)	-	-	-	-	-	-
Sulfate (SO_4)	8.0	2.31	46.72	11.60	5.8	46.7
Chloride (Cl)	3.3	Trace	90.0	4	Trace	17
Fluoride (F)	Trace	0	0.6	0	Trace	0
Nitrate Nitrogen	0.15	Trace	5.0	5.0	Trace	1.7
Total Solids	56	12	350	64	46	264
Hardness as $CaCO_3$	32	13	225	33	20	225
Alkalinity as $CaCO_3$	22	8	130	24	20	130

1/ Not in parts per million. A measure of hydrogen-ion concentration.

20. Sanitary quality of ground water is generally satisfactory if taken from properly constructed wells which are located a safe distance from sources of pollution.

WATER USE

21. Water uses considered are domestic, agricultural, and industrial. Domestic water includes that used by commercial establishments such as stores, hotels, restaurants, and markets, as well as water used for bathing, cooking, washing, cleaning, and other household purposes. Industrial water includes process, cooling, boiler feed, and miscellaneous industrial water. Agricultural water is used for stockwatering, spraying, irrigation, and other miscellaneous agricultural water uses.

22. Rural and agricultural water use. - Rural domestic and agricultural water supplies depend on many small sources. In general, they have little effect on the available water supply, are not affected by other water supply requirements, and are important in the subregional water supply picture only when a large amount of water is used for irrigation.

23. The private rural water systems supply domestic and agricultural water to about 295,500 persons. These systems include 30,545 farm systems and 43,255 rural domestic systems (total 73,800). They supply approximately 22 million gallons of water per day for all uses except irrigation. Each system supplies an average of approximately 300 gallons per day.

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24. The results of a survey by the U. S. Department of Agriculture on farm water supply are given below:

Type of water shortage	Farms reporting water shortage Number	% of Total 1/
Domestic supply	10,400	34
Livestock watering	9,500	31
Spraying	2,100	7

1/ The total number of farms in basin is 30,545.

25. Assuming that the percentage of rural non-farm homes having inadequate domestic water systems is the same as for the farms, 14,700 (34 percent of 43,255) rural domestic water systems are inadequate. Obviously, some of the farm systems are inadequate for more than one use and, therefore, are included more than once in the tabulation. Eliminating this duplication, it is estimated that about 30,000 (41 percent) rural domestic and farm systems are inadequate in this subregion. The inability of many of these systems to supply adequate amounts of water may be due to faulty development rather than to lack of ground water.

26. Irrigation water use. - In 1949, 2,020 acre feet of water (647 million gallons) were used for the supplemental irrigation of about 4,400 acres of crops in 136 systems. Natural lakes, ponds, and streams supplied irrigation water for approximately 1,675 acres. Constructed ponds supplied water for approximately 570 acres and wells, canals and municipal systems supplied water for the remaining acreage.

This water use is not significant at present, averaging five million gallons per day over about a 130 day frost-free period. Some farms in the subregion indicated that they would be short of water if they wanted to irrigate.

27. Supplemental irrigation is water sprayed onto the land once or twice per week in amounts such that rainfall plus supplemental irrigation water total one to two inches per week. Practically all of this water is taken up by the crops or evaporates.

28. Municipal and industrial water use. - Of the 640.4 million gallons per day of fresh water used by all industrial and municipal water systems in the subregion, industry uses 567.8 million gallons per day. One hundred sixty-one public water systems supply 87.2 million gallons per day of which 72.6 are for domestic use by 630,700 persons and 14.6 are for industrial use. Industries supply an additional 553.2 million gallons per day of fresh water for their own use.

29. The five largest water-using communities in Subregion "A" are given below:

Community	Water used (Million gallons/day) Total	Industrial
Berlin, New Hampshire	76.75	75.32
Rumford, Maine	51.05	50.60
Kennebec Water District	48.84	47.42
Madawaska, Maine	47.24	47.05
Woodland, Maine	40.09	39.89

All five communities are located on large streams. Small but significant amounts of water are used in 182 towns and cities, most of which have municipal water systems.

30. Industrial water use. - Total industrial water use in the subregion is divided as follows:

Process water 419.9 million gallons per day (74.0%).

Cooling water 118.7 million gallons per day (20.9%).

Boiler feed and miscellaneous 29.2 million gallons per day (5.1%).

Total - 567.8 million gallons per day.

31. Industrial water use may also be divided by type of industry as follows:

Pulp and paper industry 485.1 million gallons per day (85.4%).

Textile industry 22.7 million gallons per day (4.0%).

Thermal electric plants 21.8 million gallons per day (3.8%).

Food processing 19.7 million gallons per day (3.5%).

Other - 18.5 million gallons per day (3.3%).

32. Surface water use. - Of the 640.4 million gallons per day of fresh water used by municipal and industrial water systems in this subregion, 625.8 million gallons per day come from surface sources. One hundred and four public systems which obtain water from these surface sources supply a total of 79.9 million gallons per day. The remaining 545.9 million gallons per day are supplied and mostly utilized by industry.

33. Ground water use. - There are 12.5 million gallons per day of ground water used in the subregion. Fifty-three public water systems supply 5.3 million gallons per day. The remaining 7.2 million gallons per day are supplied and used by industry.

34. Four public water systems supply 2.1 million gallons from a combination of surface and ground water sources.

35. Re-use of Water. - After use and discharge, industrial and domestic water becomes available for other water users, provided the quality of the water is satisfactory for the intended purposes. In this subregion the stream waters are in Condition IV or V below 63 out of 129 communities from which domestic or industrial wastes are discharged. Condition IV waters are "severely" polluted and are unsuitable for domestic and most agricultural and industrial uses. Condition V waters are grossly polluted and suitable for no water supply uses.

36. Castine, Maine water supply. - The Castine water supply is taken from one surface source, two wells and several springs. Its safe yield is approximately the water consumption of the community served. It is estimated that consumption by 264 services averages 0.100 to 0.125 million gallons per day. Critical shortages of water developed in 1952 and 1953 indicating that additional water sources should be developed to meet the demands or the demands should be reduced. Unfortunately, the sources and all but six of the services are unmetered so that actual consumption and production of water are unknown. The six metered services include four very small hotels, a golf course which uses the water for sprinkling, and the Maritime Academy which uses about 15,000 gallons per day.

If the estimate of 0.125 million gallons per day is correct, the average per service consumption of about 473 gallons per day is excessive for a residential community.

37. Salt water use. - In addition to the fresh water used in this subregion, a total of 171.17 million gallons per day of salt water are used for industrial purposes, which may be divided as follows:

Cooling water, 157.68 million gallons per day (92%).

Process water, 11.8 million gallons per day (7%).

Miscellaneous, 1.69 million gallons per day (1%).

Total - 171.17 million gallons per day.

Industrial salt water use may also be divided by type of industry as follows:

Steam plant, 154.50 million gallons per day (90%)

Fish, 14.08 million gallons per day (8%)

Miscellaneous, 2.59 million gallons per day (2%)

FUTURE WATER NEEDS

38. The population and water consumption trends for each river basin and a number of localities are presented graphically in the individual river basin chapters. The trend lines indicate that in the year 2000, population and water use may range from 1.02 to 3.75 times the present, depending on the locality within the subregion. Prudent planning for the future should envision

a requirement for water for the year 2000 of about twice the amount presently used. Although future uses of water in industry and agriculture cannot be predicted with assurance, it is assumed that water use for these purposes will also be twice the amount presently used. Given below in Table 13, is a tabulation of the estimated increase in water use for the river basins included in this subregion.

Table 13 - Estimated increase in water use for the river basins in Subregion "A"

River basin	Ratio of anticipated water use in the year 2000 to present water use
Maine Coastal Streams	2 to 1
Saco River	2 to 1
Kennebec River	3 to 1
Penobscot River	2 to 1
Presumpscot River	2.4 to 1
St. Croix River	2 to 1
Androscoggin River	1.5 to 1
Saint John River	2 to 1

39. Future availability of water. - Except at Castine, Maine, a great surplus of water will be available throughout the subregion, at least to the year 2000. This great surplus of water could support new wet industries if transportation, public utilities, labor and other essentials could be provided.

40. Future availability in the Passamaquoddy Bay area. - The estimates for the eastern coastal portion of the subregion may be low if tidal hydro-electric power is developed at Passamaquoddy Bay. Before the water supply resources of this portion of the subregion would be taxed, the increase in

water use could be considerably greater than the two times estimated. However, because there are no fresh water sources which could supply large quantities of water (100 million gallons per day or more) in this area, careful consideration should be given to the water needs of potential industries which might exert a large demand in a relatively small area.

41. Future water supply for Castine, Maine. - It is not known whether Castine's water shortages during 1952 and 1953 were due to inadequate supply or to a high rate of consumption. If the shortages were due to an inadequate water supply, and if it is economically feasible, additional water should be developed.

42. This additional water might be supplied by developing the local limited ground water, or by developing a surface supply from Bog Brook, which drains into Wadsworth Cove. Either of these alternates would require an engineering study to determine their suitability and economic feasibility. Financing of an additional supply would probably require charging double or more the present rates.

43. The need for additional water at Castine depends upon its ability to attract new industry or more recreational use. In common with other small sea coast towns located on rocky peninsulas, it should not attempt to attract industry and recreational developments that require large amounts of fresh water.

44. Future development of rural and agricultural supplies. - Rural domestic and agricultural water supply are not considered above. In general, except for irrigation water, these supplies have little effect on the available water supplies in the subregion and are not affected by other water supply requirements. 20,000 ~~27,500~~ out of 73,800 rural water supplies are inadequate to meet present needs. Although the total number of rural water supplies may not increase markedly, more of them may become inadequate due to the greater demands of modern plumbing systems for water. Ground water investigations are needed to outline source areas favorable for the development of both large and small water supplies. The information obtained from these investigations would serve as a basis for determining the most economical methods for the development of dependable ground water supplies.

45. Future development of irrigation water supply. - Some farms in the subregion indicated that their present supplies would be inadequate if irrigation were adopted. Although future needs for irrigation are not known, the demand for irrigation water could increase markedly and could significantly reduce the water available in small tributaries if improved practices make irrigation profitable on more farms or if the agricultural pattern changes. This reduction could affect municipal and industrial supplies as well as other irrigation water supplies and hydro-electric power developments, and would force consideration of the legal basis for the use of water for irrigation purposes.

46. Future quality. - The quality of the water in the future will depend on the action taken to maintain or improve the present water condition by control of municipal and industrial pollution and to a small degree by improved land use practices to control erosion.

CONTROL OF RESERVOIRS FOR PUBLIC WATER SUPPLIES

47. The following reservoirs are controlled for public water supply:

Auburn Water Works - Owns 80% of the shore line of Lake Auburn and prohibits all recreational activities on the portion it owns.

Berlin, New Hampshire - Swimming and boating are prohibited in Horne and Bean Brooks and in the Ammonoasuc River.

Gorham, New Hampshire - Fishing and swimming are banned in Icy Gulch and Perkins Brooks.

Augusta Water District - Controls Carleton Pond exclusively for public water supply.

Bartlett, New Hampshire - Does not allow fishing and swimming in Albany and Bartlett Brooks.

Conway, New Hampshire - Does not permit swimming in Dry Brook. Fishing is allowed.

Freedom, New Hampshire - Does not permit fishing, swimming or boating in the tributary to Cold Brook, from which the public water supply is obtained.

Jackson, New Hampshire - Does not permit swimming in Meserve Brook. Fishing is allowed.

North Conway, New Hampshire - Does not allow swimming in Kearsarge and Artist Falls Brooks. Boating and fishing are not restricted.

Portland Water District - Restricts an area of Sebago Lake near the intake. The remainder of the lake is unrestricted for fishing, swimming, and boating purposes. Fishing and shore use of all other municipal surface water sources are permitted.

48. Restrictions on the use of water supply reservoirs for recreation have not significantly limited recreational activities in this subregion. Additional water resources are available in this area to meet the needs of swimming, boating and fishing without infringing on the water resources now reserved for public water supplies.

BENEFITS TO WATER SUPPLY FROM STREAM FLOW REGULATION

49. Storage reservoirs operated for stream regulation will generally increase the safe yield of the river at downstream points. Reservoirs included in the inventory power plan (See Section VII) would increase the safe yield. The increase of safe yield would depend on the number of projects installed and on the method of reservoir operation, governed by the needs of

downstream power plants and other water users. Sections III and VII present a discussion of the existing and potential storage and stream regulation.

50. Since the quantity of water available at the present time is in excess of the estimated water supply needs in the year 2000, there would be no benefits to water supply as a result of new hydro-electric power storage reservoirs. Increased discharges would improve the quality of the water, but not to the extent that monetary benefits will result in the foreseeable future.

CONCLUSIONS

51. It is concluded that:

a. A large surplus of water will be available for water supply in Subregion "A" for at least the next 50 years on the basis of needs now foreseeable, except as indicated in conclusion b. Most of this surplus will probably be surface water.

b. Castine, Maine has a water shortage which is probably aggravated by excessive use.

c. The surplus of water available is a valuable natural resource and could be attractive to new industries having large water demands.

d. The natural surface waters in this subregion have a hardness ranging from 8 to 156 parts per million; have a low to moderate mineral content, 16 to 152 parts per million;

generally range from acid to slightly alkaline, pH of 5.0 to 9.0; and may be corrosive. They are suitable for most water uses, but some must be treated to control corrosiveness, hardness, color, and turbidity.

e. The present quality of 563 miles of the stream waters in this subregion is impaired for most water supply uses by discharge of sewage and industrial wastes. These 563 miles of streams in Conditions IV and V are mostly located in the Androscoggin, Kennebec, and Penobscot River Basins. The longest stretch is along the main stem of the Androscoggin River for a distance of 124 miles from Berlin, New Hampshire to Topsham, Maine. This present quality of 322 miles of stream waters have been impaired for some water uses. There are 4,365 miles of fresh surface waters that are essentially unaffected. Further deterioration of stream waters would be prevented by treatment of waste discharges from present or new wet industries.

f. The highest priority water use is for domestic water supply. The prohibition of swimming, boating, and/or shore use of public water supply reservoirs does not significantly limit these recreational activities in this subregion. Ample water resources are available to meet the foreseeable recreational needs without infringing on the very small portion of the water resources now reserved exclusively for domestic water supply.

g. Data for the quality of waters of the rivers and principal streams in this subregion are adequate to define the general usefulness of the untreated water for industrial uses.

h. Ground water is available throughout most of the subregion in small quantities which can be developed to meet the needs of individual rural homes and farms for domestic and agricultural water, except irrigation. Moderate and large quantities of ground water can be developed in various areas, generally along the major rivers.

i. The ground waters vary greatly in hardness, 13 to 225 parts per million; and mineral content, 12 to 350 parts per million. The ground waters are generally suitable for all water supply uses, provided hardness, corrosiveness, and iron content are controlled as required by the needs of the users. Indications are that many wells in heavily fertilized areas are high in nitrates.

j. A sharp increase in agricultural water use for supplemental irrigation could significantly reduce the water available in small watersheds, especially during dry, hot weather and would raise a question as to the legal basis for use of water for irrigation.

k. The domestic water supply requirements of rural families have little effect on the available water supply in the subregion and, in general, are not affected by other water supply requirements.

1. Approximately ~~37~~ 41 percent (~~27,500~~ 30,000) of the 73,800 ground water supplies developed by rural families are not adequate to meet the demands for domestic and agricultural water with no allowance for irrigation.

WATER SUPPLY PLAN

52. The water supply plan is as follows:

a. Improvement of water quality. - Pollution control measures described in Section V would improve the quality of deteriorated stream water. These improvements include making the water attractive to industry where increased industrial use is desirable. Major consideration would need to be given to the water supply needs of industry and other water users in the formulation of a comprehensive pollution control plan for best water use.

b. Investigation of supplemental irrigation. - A study of supplemental irrigation should be made to determine when the amount of water used for irrigation has increased so as to threaten to affect other water uses. The study would include the annual collection of data on the acreage irrigated, the amount of water used, the sources of water and the types of crops irrigated. Assuming data would be collected by existing agricultural field staffs and organizations, it is estimated that the services of one man, part-time, would be required to analyze data and coordinate field activities. The estimated annual cost of the investigations is approximately $6,500.

c. <u>Ground water investigations</u>. To determine the ground water potential of Subregion "A", the following studies on the ground water should be made.

Location	Approximate area in Square miles	Type of Study
Upstream areas, Sebago Lake to north Maine Coastal	11,947	Reconnaissance
Rural, small towns, some suburban areas and central Maine Coastal	5,605	Intermediate
Urban areas and southern Maine Coastal	5,319	Comprehensive

(1) A reconnaissance study would entail the collection of a limited amount of data on springs, wells, and major ground water supplies. This type of study would also include the collection of a limited number of samples for chemical analyses and a very general geologic mapping program.

(2) An intermediate study would involve a fairly thorough inventory of data on springs and wells, and the collection of a considerable number of samples for chemical analyses. In addition, it would include sufficient geologic investigations and mapping to define the principal water bearing units, their areal extent, thickness and water bearing characteristics.

(3) A comprehensive study would include mapping the surficial and bed rock geology of the area as needed to delineate the areal extent of the water bearing formations, the collection and evaluation of sub-surface data such as records of wells, test borings, springs, their logs and yields, and chemical analyses of water samples in order to determine thickness of the aquifers,

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their potential yield, and the quality of the water. This type of study would outline source areas favorable for the development of both large and small water supplies.

The information obtained from these investigations would also aid in determining the best methods for developing dependable ground water supplies. The studies needed to properly evaluate the availability of ground water for public supply, industry and domestic use, including field work and preparation, but not publication, of the necessary reports would cost about $435,000.

SECTION V - POLLUTION CONTROL

1. This section presents an inventory of pollution contributed to the water resources of Subregion "A," the effects of pollution on present water conditions, pollution measures in effect, and such stream classifications as have been legally adopted for best use of the water resources. A provisional plan is offered to serve as a guide in planning the pollution control aspects of water resource developments. This provisional plan illustrates the approximate water quality improvement that could be effected by the sewage and industrial waste treatment shown. Costs of pollution control measures and the benefits from improved water quality are discussed.

PRESENT STATUS OF POLLUTION AND POLLUTION CONTROL

2. In the economic development of Subregion "A," population and industry have become most concentrated in the lower one-third of the principal river basins and along the south Maine coastal area in particular. It is in these areas that the largest use of the water resources for the transportation of sewage and industrial wastes has been made. While the use of the water resources as the final place of disposal for waterborne wastes is indispensable, the discharge of large volumes of untreated sewage and industrial process wastes has resulted in serious deterioration of receiving water qualities. It

is this use that is most in conflict with other legitimate and desirable water uses, especially recreation, shellfish operations, industrial water supply and, in some instances, public and agricultural water supply.

3. Pollution contributed to water resources. - In recording the sources of pollution in this subregion, the following procedures were conformed to in order that a reasonable and equitable tabulation of data would result:

a. A municipality having multiple public sewers discharging to the same watercourse was counted as one source of pollution.

b. Where a municipality has multiple public sewers discharging to and affecting more than one watercourse, each watercourse was counted as receiving one source of pollution.

c. In population centers, multiple private domestic outlets discharging to a single watercourse were counted as one source of pollution.

d. An industry having multiple waste outlets has been counted as a single source of pollution.

e. An industry discharging both organic and inorganic wastes has been recorded as only one source of pollution in whichever category is most significant to the problem.

f. Industries discharging employee sewage only were counted as sources of sewage pollution.

g. Industries discharging both process wastes and sanitary wastes have been counted as sources of industrial wastes.

h. Sources of sewage pollution contributed to by less than 50 persons have been excluded as not significant to overall water resource development.

4. On the above bases there have been recorded a total of 500 separate significant sources of pollution in Subregion "A." Sewage and organic industrial wastes have been computed to contribute a total population equivalent of approximately 8,170,700 persons to the pollution loads transported by the seven principal river systems and the coastal streams. Inorganic wastes, including those discharged in combination with predominantly organic wastes, contribute significant amounts of chemicals, metals, suspended matters and similar materials.

5. Sources of sewage pollution. - Of the total of 500 separate significant sources of pollution in this subregion, 304 are caused by discharges of sewage from municipalities, other population centers, institutions, schools, military establishments and industrial plants. Included are effluents from sewage treatment facilities, adequate or inadequate, of which there are 32. These 304 sources of sewage pollution are reported to have a total contributory population of 582,825 persons and the population equivalent has been computed to be in excess of 580,000 persons, including the unreported populations at military establishments. Sewage discharges account for approximately

seven percent of the total pollution load discharged to the water resources of Subregion "A."

6. One of the sources of sewage pollution has a contributory population of more than 50,000 persons; four are contributed to by populations ranging from 20,000 to 50,000 persons; 10 from 10,000 to 20,000; 14 from 5,000 to 10,000; 70 from 1,000 to 5,000; 89 from 500 to 1,000; and 116 are contributed to by less than 500 persons.

7. Sources of industrial waste pollution. - The 196 sources of industrial waste pollution are caused by the discharge of process wastes from 118 food and food products plants, 41 textile mills, 24 paper and allied products mills and the remaining 13 from a miscellany of manufactures. Many of these plants also discharge sanitary wastes from employees. One hundred and ninety of the industrial wastes are predominantly organic in nature while six are primarily inorganic. When plants are operating at or near capacities, the population equivalent of organic industrial wastes is computed to be about 7,590,680 persons, approximately 92 percent of the total pollution load to watercourses. Of this total, the pulp and paper industry accounts for a population equivalent of about 6,400,000; the potato starch industry, 558,000 persons; the textile industry, 225,000 persons; the food and food products industry (other than starch), 321,000 persons; and all other industries account for the remaining population equivalent of 86,500 persons.

8. Not counted above as sources of industrial waste pollution are probably more than 100 sawmills scattered throughout the subregion. Sawdust and other wood products wastes entering streams seriously interfere with normal aquatic life and, on occasion, other water uses. Many of the sawmills are portable and move from place to place. In some cases, sawmills discharge directly to watercourses and in others sawdust piles are located so that these wastes may be washed into streams during run-offs. Sawmill operations create a special problem of water pollution in this subregion.

9. Table 14 summarizes the data on sources of sewage pollution and Table 15 summarizes the data on sources of industrial waste pollution. For detailed information on individual sources of sewage and industrial waste pollution in Subregion "A," reference is made to Section V in each of Chapters III through X.

Table 14 - Sources of pollution - Municipal, Subregion "A"

Basin or area	Sources of pollution (in number of municipalities*)	Population served by sewerage system	Amount of pollution discharged to water-course (in terms of equivalent number of people)**
Saint John River	21	29,510 1/	27,850 1/
St. Croix River	3	6,060	6,060
Penobscot River	51	73,320	76,890
Kennebec River	59	95,035	97,385
Androscoggin River	40	110,540	117,860
Presumpscot River	11	11,715	11,525
Saco River	15	22,100	21,420
Maine Coastal	104	234,545	221,043
Totals	304 2/	582,825 1/ 3/	580,033 1/ 3/

* Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers or other population centers.

** Includes industrial wastes discharged into municipal sewerage systems.

1/ Does not include populations served at Limestone and Presque Isle military reservations.

2/ Includes 39 industrial plants having no process wastes but discharging sanitary wastes from a total of 7,044 employees. Mexico, Dixfield, South Paris and Lewiston, Maine, and Berlin and Gorham, New Hampshire, each have separate municipal discharges to two watercourses and each separate discharge has been counted as a source of pollution. Auburn, Maine, discharges municipal wastes to three watercourses, each discharge being counted as a separate source of pollution.

3/ Includes summer populations where these are known to be significant.

Table 15 - Sources of pollution - Industrial, Subregion "A"

Basin or area	Number of sources 1/ Organic	Inorganic 2/	Population equivalent (in terms of number of people) 2/	% of total Subregion "A"
Saint John River	36	0	680,510	9.0
St. Croix River	1	0	210,000	2.8
Penobscot River	15	0	2,404,120	31.6
Kennebec River	41	0	1,545,050	20.4
Androscoggin River	20	2	2,523,600	33.2
Presumpscot River	4	0	108,130	1.4
Saco River	9	1	8,310	0.1
Maine Coastal	64	3	110,955	1.5
Totals	190	6	7,590,675	100.0

1/ Industries having separate outlets discharging wastes directly to watercourse.

2/ Population equivalent does not apply to inorganic wastes.

EFFECTS OF POLLUTION ON PRESENT CONDITION OF WATER RESOURCES

10. Water resources transporting pollution. - Over some course of their flows, pollution is transported by the main stems of the seven principal rivers and 80 of their tributaries; by the main stems of 18 of the coastal streams and five of their tributaries; and by seven lakes and one pond. The main stems of these watercourses transporting pollution have a total length of flow of approximately 2,530 miles.

11. <u>Miles of watercourse seriously affected by pollution</u>. - Five hundred and seventy-nine miles of watercourse in Subregion "A" are seriously affected by pollution transported. Seventy-two of these miles are in nuisance condition during critical periods of flow and temperature and the water qualities over these stretches are generally unsuitable for any legitimate purpose. The other 507 miles of seriously polluted stretches of streams are not in nuisance condition during critical periods but are of a low quality equivalent to that generally acceptable for such uses as power development, navigation, other limited industrial purposes and for transportation of the present pollution load without nuisance. The aesthetic quality of these waters is poor.

12. <u>Miles of watercourse significantly affected by pollution</u>. - There are about 380 miles of stretches of main stems where pollution transported has resulted in a significant effect on water qualities. Over these stretches of streams, which vary in length from about one mile to many miles in some cases, the water condition is approximately equivalent to a quality generally suitable for such uses as recreational boating, irrigation of crops consumed after cooking, habitat for wildlife and common food and game fishes indigenous to the region and for some industrial processes without treatment and others with treatment. Some of these waters are of a reasonably good quality while others may not always be of a suitable aesthetic quality.

13. Lakes and ponds affected by pollution. - Of the fresh water resources, seven lakes and one pond receive significant pollution. In three instances, the effect is confined to the immediate vicinity of the outfall sewer, while in the others the effects are spread over a radius of several hundred yards or more. In Ward Pond and Marancook Lake, the effect of pollution on water quality is serious and the affected waters are suitable for very limited uses. In the other six lakes, the pollution is less serious and the affected water areas are suitable for such uses as recreational boating, habitat for wildlife and common food and game fishes indigenous to the region and for irrigation of crops consumed after cooking.

14. Coastal salt waters affected by pollution. - The salt waters fronting all of the principal river systems draining into Maine coastal waters and those fronting at least 16 of the smaller coastal rivers and streams have been significantly affected by pollution. In addition, there are many coastal areas affected by pollution discharged directly into these waters by coastal municipalities and industries.

15. There are 58 closed clam flat areas along the Maine coast which represent thousands of acres of an important natural resource. In 1946 and 1947, the Maine Sanitary Water Board, in cooperation with the Maine State Bureau of Health, State Department of Agriculture and State Department of Sea and Shore Fisheries, conducted a survey of these areas closed to shellfish harvesting and, as a result,

concluded from the findings that it would be unwise to open any of these areas since all were found to be polluted by sanitary sewage.

16. Between June and September 1946, the Division of Sanitary Engineering of the Maine Department of Health and Welfare made a sanitary survey of salt water bathing areas from Kittery to Cape Elizabeth, a coastline distance of 95 miles of which 28 are considered bathing beach areas. Based on the average B. coli per cubic centimeter found by bacteriological tests, it was shown that 9 percent of the bathing beach area surveyed was definitely unsatisfactory, 18 percent was of questionable safety and the remaining 73 percent was satisfactory under the Maine rules and regulations relating to bathing areas. On the basis of the sanitary survey, it was found that 18 percent of the 28-mile bathing beach area was subject to serious pollution, 35 percent to sufficient pollution to endanger the use of the waters for bathing and 47 percent was subject to minor pollution which did not appear to affect bacteriological qualities beyond standards set by Maine rules and regulations. Studies of the remaining coastal areas subject to pollution will probably show much the same results as those determined for the southwestern coastal areas.

17. <u>Water resources unaffected by pollution</u>. - In addition to the 959½ miles of stretches of main stems of streams seriously or significantly affected by pollution, there are 1,569 miles of stretches in these same streams that receive no pollution or are relatively

unaffected by it. About half of these waters are of a very high quality, suitable for any water use. The other half is also of high quality but not suitable for public water supply unless filtered and chlorinated. In addition, in the relatively undeveloped upper portions of the river basins, there are hundreds of miles of streams and many lakes and ponds receiving only natural pollution from run-off that are of a high quality, most being suitable for any water use. Being more remote from population and industry, these water resources are most important to fish and wildlife, agricultural, recreational and power development interests at the present time. There are also large areas of the coastal salt waters not receiving pollution that are of a high quality, suitable for any water use not limited by salinity. These waters are of most interest to the commercial fishing and recreation industries.

18. Soil erosion and agricultural practices. - Although erosion of row cropland and stream bank erosion have been sufficiently severe in many places to warrant corrective measures, it has not been reported by the New Hampshire and Maine State water pollution control authorities as a significant pollution factor in relation to present water uses. Neither has the use of agricultural fertilizers or insecticides been reported as a significant pollution factor. However, the U. S. Department of Agriculture, Soil Conservation Service, reported that in 1952 there were 242 farms not using streams because of pollution and there may be others that have not been reported.

19. Table 16 summarizes by principal drainage basin areas the effects of pollution on receiving water conditions. The approximate present condition of these waters is indicated by their suitability for use based on the tentative water quality standards of the New England Inter-state Water Pollution Control Commission. Conditions I through V are approximately equivalent to Classes A through E of the interstate standards. All of the water uses shown in Table 16 may not be made or contemplated to be made at the present time. Suitability for use is intended solely as an effective means of describing present water conditions. Table 17 is a reproduction of the interstate water quality standards.

POLLUTION CONTROL MEASURES IN EFFECT

20. Sewage treatment facilities. - Only 32 of the 304 separate sources of sewage pollution in Subregion "A" have been provided with treatment facilities. In addition, a hotel in Randolph, New Hampshire, has a subsurface sewage disposal system serving 150 persons causing no stream pollution but included here to credit satisfactory sewage facilities. Twenty-six of these facilities provide septic tank or primary treatment and seven provide secondary treatment. Primary sewage treatment facilities have a total contributory population of 57,460 persons, including a summer population of 40,000 served by the treatment facilities at Old Orchard Beach. The six secondary sewage treatment plants are all small and have a total connected population of only 2,590 persons. There are 272 sources of sewage

Table 16 - Approximate* effects of pollution on quality of water resources, Subregion "A"

Key to symbols

Condition	Description
I	Suitable for any water use. Character uniformly excellent.
II	Suitable for bathing and recreation; irrigation and agricultural uses; good fish habitat; good aesthetic value. Acceptable for public water supply with filtration and disinfection.
III	Suitable for recreational boating, irrigation of crops not used for consumption without cooking, habitat for wildlife and common food and game fish indigenous to the region. Suitable for public water supply if shown by technical studies.
IV	Suitable for transportation of sewage and industrial wastes without nuisance and for power, navigation and other industrial uses for which it is acceptable.
V	Waters falling below the above descriptions--considered unsatisfactory for any legitimate purpose.
*	Tentative pending detailed classification studies.

Basin or area	Number of sources of pollution: Sewage	Industrial	Approximate present conditions in miles: I	II	III	IV	V
Saint John River	21	36	254	58	66	87	4
St. Croix River	3	1	43	0	9	16	0
Penobscot River	51	15	191	102	50	59	45
Kennebec River	59	41	252	43	53	148	15
Androscoggin River	40	22	7	84	73	159	0
Presumpscot River	11	4	28	0	13	2	8
Saco River	15	10	7	141	36½	5	0
Maine Coastal	104	67	0	359	80	31	0
Totals	304	196	782	787	380½	507	72

pollution having a total contributory population of 522,775 persons, nearly 90 percent of the total sewage pollution load, that are discharged directly to watercourses without treatment.

21. Industrial waste treatment facilities. - Of the 196 separate significant sources of industrial waste pollution in Subregion "A," only 11 have been provided with any degree of treatment. For the most part, treatment is minor, such as fine screening, sedimentation or lagooning, and the population equivalent of the treated effluents is approximately 1,587,500 persons. The 185 sources of untreated industrial wastes have a combined population equivalent of about 6,002,000 persons.

22. Adequacy of sewage treatment facilities in operation. - Eighteen of the existing sewage treatment facilities are adequate in capacity and design, while 15 are not. Sixteen of these plants provide satisfactory treatment for a total connected population of 6,500 persons as do two plants serving military bases for which populations have not been reported. Fifteen sewage treatment plants are inadequate in capacity and these have a total contributory population of approximately 53,700 persons, about 90 percent of the population served by treatment facilities. Nineteen of the sewage treatment facilities are reported to be satisfactorily operated, while 14 are not operated satisfactorily.

23. Adequacy of industrial waste treatment facilities in operation. - Only two of the 11 existing industrial waste treatment

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TABLE 17
SUBREGION "A"

NEW ENGLAND INTERSTATE WATER POLLUTION CONTROL COMMISSION
TENTATIVE PLAN FOR CLASSIFICATION OF WATERS
(As Revised and Accepted December 8, 1950)

	CLASS A	CLASS B	CLASS C	CLASS D
	SUITABILITY FOR USE			
	Suitable for any water use. Charactor uniformly excellent.	Suitable for bathing and recreation, irrigation and agricultural uses; good fish habitat; good aesthetic value. Acceptable for public water supply with filtration & disinfection.	Suitable for recreational boating, irrigation of crops not used for consumption without cooking; habitat for wildlife and common food and game fishes indigenous to the region.	Suitable for transportation of sewage and industrial wastes without nuisance, and for power, navigation and other industrial uses.
	STANDARDS OF QUALITY			
Dissolved oxygen	Not less than 75% sat.	Not less than 75% sat.	Not less than 5 p.p.m.	Present at all times.
Oil and grease	None	No appreciable amount	Not objectionable	Not objectionable
Odor, scum, floating solids, or debris	None	None	None	Not objectionable
Sludge deposits	None	None	None	Not objectionable
Color and turbidity	None	Not objectionable	Not objectionable	Not objectionable
Phenols or other taste producing substances	None	None	None	
Substances potentially toxic	None	None	Not in toxic concentrations or combinations	Not in toxic concentrations or combinations
Free acids or alkalies	None	None	None	Not in objectionable amounts
Coliform bacteria	*Within limits approved by State Department of Health for uses involved	Bacterial content of bathing waters shall meet limits approved by State Department of Health and acceptability will depend on sanitary survey.		

* Sea waters used for the taking of market shellfish shall not have a mediam coliform content in excess of 70 per 100 ml.

NOTE: Waters falling below these descriptions are considered as unsatisfactory and as Class E.
These standards do not apply to conditions brought about by natural causes.
For purpose of distinction as to use, waters used or proposed for public water supply shall be so designated.

facilities are adequate in capacity. The other nine industrial waste treatment facilities discharge unsatisfactory effluents that have a total population equivalent of nearly 1,294,000 persons. Operation of four of the treatment facilities is satisfactory and is unsatisfactory at the remaining seven.

24. Progress in construction of treatment facilities. - During the period 1946-1954, a total of six sewage treatment facilities and one industrial waste treatment facility was constructed. Three small primary sewage treatment plants were constructed to serve a total population of 1,000 persons and three small secondary sewage treatment plants were placed in operation to serve a total of about 2,000 persons. The industrial waste treatment facility constructed was a lagoon designed to store a portion of the waste sulfite liquor from a large pulp and paper mill on the Androscoggin River.

25. Tables 18 through 22 summarize the data on sewage and industrial waste treatment facilities in operation and the progress in their construction in Subregion "A."

Table 18 - Existing treatment facilities - Municipal, Subregion "A"

Degree of treatment provided	Number of municipalities* served	Number treatment plants	Population served
Primary	25	26	57,460 1/
Secondary 2/	7	7	2,740
No treatment	272	0	522,775

* Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns, significant institutions, resorts, recreational centers or other population centers; sanitary sewage wastes discharged by industry directly to watercourse and industrial wastes discharged into municipal sewerage systems.

1/ Does not include populations at two military air bases in Saint John River Basin.

2/ Includes a small plant serving 150 persons at a resort hotel, having subsurface disposal of effluent and not counted as a source of pollution.

Table 19 - Existing treatment facilities - Industrial, Subregion "A"

Type industry	Number of industrial plants	Number of industrial plants having: Treatment facilities	No treatment facilities	Undetermined facilities
Food and food products	118	5	113	0
Textile mill products	41	1	40	0
Paper and allied products	24	2	22	0
Leather & leather products	5	2	3	0
Machinery	1	0	1	0
Rubber & rubber products	1	0	1	0
Primary metal	2	0	2	0
Miscellaneous	4	1	3	0
Totals	196	11	185	0

* Industries having separate outlets discharging wastes directly to watercourse.

Table 20 - Adequacy of existing treatment facilities - Municipal, Subregion "A"

Basin or area	Number of municipal* treatment facilities	Adequacy with relation to: Capacity: Satis-factory	Capacity: Unsatis-factory	Operation: Satis-factory	Operation: Unsatis-factory
Saint John River	5	3	2	3	2
St. Croix River	-	-	-	-	-
Penobscot River	3	1	2	1	2
Kennebec River	4	2	2	2	2
Androscoggin River	5	4 1/	1	5	0
Presumpscot River	-	-	-	-	-
Saco River	3	2	1	2	1
Maine Coastal	13	6	7	6	7
Totals	33	18	15	19	14

* Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers or other population centers.

1/ Includes a small plant serving 150 persons at a resort hotel, having subsurface disposal of effluent and not counted as a source of pollution.

Table 21 - Adequacy of existing treatment facilities - Industrial, Subregion "A"

Basin or area	Number of industrial* treatment facilities	Adequacy with relation to: Capacity: Satis-factory	Capacity: Unsatis-factory	Operation: Satis-factory	Operation: Unsatis-factory
Saint John River	2	0	2	0	2
St. Croix River	-	-	-	-	-
Penobscot River	-	-	-	-	-
Kennebec River	2	0	2	0	2
Androscoggin River	4	1	3	1	3
Presumpscot River	-	-	-	-	-
Saco River	-	-	-	-	-
Maine Coastal	3	1	2	1	2
Totals	11	2	9	2	9

* Industries having separate outlets discharging wastes directly to watercourse.

Table 22 - Progress in construction of pollution abatement facilities, Subregion "A"

Year	Municipal		Industrial	
	Sewage treatment plants completed	Design population	Waste treatment plants completed	Amount of wastes treated (in terms of equivalent number of people)
1946	1	500	0	-
1947	2	1,000 1/	0	-
1948	2	1,340 2/	0	-
1949	0	-	0	-
1950	0	-	0	-
1951	1	150	1 3/	250,000
Totals	6	2,990	1	250,000

1/ Includes design population of both small plants at Auburn, Maine; one constructed in 1947 and one in 1948, reported as having a combined capacity of 500 persons.

2/ Design population of one plant not reported; present population served has been taken to be 1,340. Does not include design population of one small plant as noted in Footnote 1.

3/ Storage lagoon for waste sulfite liquors from pulp mill with capacity for 20 percent of production during critical stream flows.

POLLUTION CONTROL LEGISLATION IN EFFECT

26. Maine state legislation. - In 1941 the Maine legislature enacted the Sanitary Water Board Law which was amended in 1945, 1947 and 1949. This law was inadequate to enforce pollution abatement inasmuch as it was, in effect, a limited licensing law. In 1951 the legislature repealed and replaced Section I of the Revised Statutes,

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Chapter 72, and created the Water Improvement Commission which replaced the Sanitary Water Board. In 1953, Chapter 72 was further revised and provisions made for standards of classification, classification procedure, enforcement of classifications adopted and other regulations provided in the Act. The Water Improvement Commission is directed to make studies, investigations and recommendations to persons responsible for conditions of pollution in the waters of the State as to ways and means such pollution may be controlled in the public interest. The Commission shall make recommendations to each legislature with respect to the classification of the rivers, waters and coastal flats based on the classification standards provided in Section I-A.

27. Although the revised Section I of the Revised Statutes, Chapter 72, stipulates that the Maine Water Improvement Commission may employ subject to provisions of the personnel law, such employees and consultants as needed to carry out the provisions of this chapter, the Commission does not at present have adequate personnel or funds to carry out needed studies and investigations nor for public information programs.

28. New Hampshire state legislation. - Chapter 166-A, Revised Laws of New Hampshire (as amended by Chapter 183, Laws of 1947) established the New Hampshire Water Pollution Commission and provided it with legislation for the control and abatement of pollution of the surface waters of the State. The law instructs the Commission, following a specified procedure of surveys, investigations, reports

and public hearings,to recommend to the legislature classifications of the surface waters of the State in the best interests of the public. Following adoption of the classifications by the legislature, the Commission is empowered to take whatever steps are necessary to bring the quality of the waters into the specified classification. The New Hampshire Water Pollution Commission reports adequate legislation in effect to control pollution of the water resources of the State.

29. Special court controls in effect. - The Supreme Judicial Court in Equity for Androscoggin County in Maine has issued several decrees relative to control of pollution of the Androscoggin River by paper companies. The Decree of 1948 appointed an Administrator and provided him with rigorous controls over allowable discharges of sulfite waste liquors and the power to require addition to the river of up to 1,000 tons of soluble nitrate between June 15 and September 15 each year and in the judgment of the Administrator, this period may be extended to October 1. The paper companies have fully complied with the controls effected by the Administrator. They have curtailed waste sulfite liquor discharges by as much as 50 percent during critical periods, constructed storage lagoons, provided the nitrate required, established stream sampling programs and sponsored studies and research on solution of paper mill waste treatment problems. Under certain conditions of low flow and high temperature, however, odor conditions may still be created in some

limited areas and more control and/or reduction of pollution load may be needed if odor conditions recur with objectionable frequency.

CLASSIFICATIONS ADOPTED FOR FUTURE BEST USE OF WATER RESOURCES

30. Classifications adopted by Maine legislature. - In 1953, acting under the provisions of Section I, Chapter 72, the Maine legislature adopted classifications recommended by the Water Improvement Commission for various of the waters in the basins of the Androscoggin, Kennebec, Penobscot, St. Croix and Saint John Rivers and for eight streams draining the coastal area. All of the streams or sections thereof that are classified are not subject to pollution at the present time and the quality of these water resources is high. To maintain this high quality in the best interest of the public, these waters were classified as Class A. As defined by Section I-A, Chapter 72, Class A is the highest classification and "shall be of such quality that it can be used for bathing and public water supplies after disinfection, and the dissolved oxygen content of such waters shall not be less than 75 percent saturation and contain not more than 300 coliform bacteria per 100 milliliters." This standard requires that there shall be no discharge of sewage or other wastes into these waters and no deposits of such material on the banks of such waters which could be transferred into the waters. Class A waters may be used for log-driving or other commercial purposes that will not lower their classification.

31. Classifications adopted by New Hampshire Legislature. - The New Hampshire legislature has classified in accordance with Chapter 166-A of the Revised Laws of New Hampshire certain portions of the Androscoggin River Basin and all of the Saco River Basin within the State. In the Androscoggin River Basin, the Swift Diamond, Dead Diamond, Moose, Peabody and Wild Rivers, Umbagog Lake and Clear Stream were classified as Class B-1. In the Saco River Basin, all of the waters were classified as Class B-1, except Dry and Meserve Brooks which were classified as Class A. Under New Hampshire law, Class A waters are the highest quality and shall be considered as being potentially acceptable for water supply uses after disinfection. Class B-1 waters are also of high quality and shall be considered as being acceptable for bathing and other recreational purposes and, after adequate treatment, for use as public water supplies. No discharge of sewage or other wastes is permitted in Class A waters and in Class B-1 waters; only the discharge of adequately disinfected secondary sewage treatment plant effluents and those industrial wastes which will not lower the water qualities for intended highest uses is permitted.

PROVISIONAL POLLUTION CONTROL, COSTS AND BENEFITS

32. Provisional pollution control plan. - In each Section V of Chapters III through X, three provisional pollution control plans were presented. These provisional plans were defined as follows:

Provisional Plan A would provide primary treatment for most sources of sewage pollution and an equivalent or similar degree of treatment for sources of industrial waste pollution.

Provisional Plan B would provide secondary treatment for each source of sewage pollution and an equivalent or substantial degree of treatment for each source of industrial waste pollution.

Provisional Plan C would provide secondary or a similar degree of treatment for all sources of pollution except where providing primary or a similar degree of treatment would result in approximately the same improved water conditions as secondary or similar treatment. All plans would provide for chlorination of sewage effluents.

33. Exceptions to the above plans were made in certain instances where only one method of treatment was shown under all three plans. These exceptions were made when the treatment shown was obviously the only reasonable and equitable method for a source of pollution, such as subsurface disposal for small sources of sewage pollution or connection of wastes to an available municipal sewerage system.

34. Provisional Plan C. - In the absence of stream classifications established by the state legislatures of Maine and New Hampshire which are required by law for a definite plan for control of pollution in the surface waters of the subregion, Provisional Plan C, as outlined in each Section V of Chapters III through X, is offered as one of the several possible plans to serve as a guide or frame of reference in planning water resource development.

35. <u>Cost estimate criteria.</u> - All cost estimates for provisional pollution control projects have been adjusted to the 1949 Engineering News-Record construction cost index. In computing annual charges for provisional pollution control projects, an interest rate of $2\frac{1}{2}$ percent and an amortization period of 30 years have been taken for all public construction. For private construction, an interest rate of 4 percent and an amortization period of ten years have been used in computing annual charges for provisional projects.

36. The cost estimates for municipal sewage treatment works construction include costs for intercepting sewers but do not include costs for sewerage systems or extensions thereto since such costs are not generally considered a part of sewage treatment costs. Where such facilities may be required, the costs would be substantial. For industrial waste treatment or disposal construction, no costs have been included for in-plant or yard changes that may be required in connection with treatment. Such costs could only be determined after detailed in-plant investigations at each manufacturing plant. In some instances the cost of in-plant or yard changes would be minor and in some others these costs may approach that of the treatment facility to be constructed. No corrections in the estimated construction costs for industrial waste treatment facilities have been made for savings that may be realized through better utilization of raw materials or recovery of valuable by-products as a result of pollution control measures taken.

37. Water quality criteria. - Subsequent discussion of water qualities in this report is based on (1) the "Tentative Plan for Classification of Waters" of the New England Interstate Water Pollution Control Commission (as revised and accepted 8 December 1950) and (2) stream flows exceeded 95 percent of the time. Where quantitative data on stream velocities, temperatures, reaeration coefficients and other self-purification factors below individual sources of pollution were not available, these data have been estimated. Water conditions I through V are approximately equivalent to water classes A through E of the interstate standards. In order to show water quality improvement under the provisional plans, it has been assumed that sources of pollution in Canada entering the international waters of the St. Croix and Saint John Rivers, would receive the same degree of treatment as sources in the United States. It is understood, however, that the control of pollution entering international waters rests with the governments of the United States and Canada through the International Joint Commission.

38. The provisional plan presented in this section is not conceived to be the most feasible or desirable plan for controlling pollution in Subregion "A." Such a plan can be determined only after best water uses have been determined and classifications adopted by the State authorities and after appropriate action by the International Joint Commission. Neither are the methods of treatment or disposal shown necessarily the only methods available to produce a

similar reduction in pollution. The provisional plan presents data sufficient on which to judge the benefits and costs of pollution control in the subregion and to serve as a guide in planning and coordinating water resources development. In serving this purpose, no attempt is made to classify any of the waters in Subregion "A" or to usurp in any way the primary rights and responsibilities of the States of New Hampshire and Maine to control the pollution of their waters or the jurisdiction of the International Joint Commission over international boundary waters.

PROVISIONAL POLLUTION CONTROL PLAN

39. Treatment and disposal facilities. - The provisional plan for pollution control for Subregion "A" would provide a total of 485 treatment facilities, 289 for sources of sewage pollution and 196 for sources of industrial waste pollution. Sewage treatment projects would treat wastes having a total population equivalent of about 578,124 persons and industrial waste treatment projects would treat wastes having a total population equivalent of 7,590,675 persons. Table 23 summarizes the data on the provisional pollution control plan and shows the number and kind of facilities that would be provided and the type and population equivalent of wastes to be treated. For details on treatment facilities for individual sources of pollution, reference is made to Provisional Plan C, Section V in each of Chapters III through X.

Table 23 - Summary of treatment facilities, Provisional Pollution Control Plan, Subregion "A" #

No. of facilities	Type of waste	Estimated population* equivalent	Type of treatment or disposal
18 1/	Sewage	74,570	Secondary treatment, chlorination
93 2/	Sewage	300,590	Primary treatment, chlorination
5	Sewage	79,470	Primary treatment, chlorination, offshore outfall sewer
11	Sewage	1,000	Connect to municipal system having secondary facilities
50	Sewage	52,514	Connect to municipal system having primary facilities
1	Sewage	400	Add secondary treatment to existing facilities
3	Sewage	4,720	Additions to existing primary treatment, chlorination
2	Sewage	30,280	Replace primary facilities
1	Sewage	4,500	Construct secondary plant jointly with another municipality
7	Sewage	17,300	Comminutor, chlorination, offshore outfall sewer
1	Sewage	50	Add chlorination only
2	Sewage	N 3/	Chlorination effluent
94	Sewage	12,530	Subsurface disposal
1	Sewage	200	Enlarge secondary plant and add chlorination
6	Sewage	1,909	Nothing required
12	Industrial	68,675	Connect to municipal system having secondary facilities
1	Industrial	DNA 4/	Connect to municipal system having secondary facilities

Summarized from Provisional Plan C as presented in Section V of Chapters III to X inclusive.

Table 23 (Continued)

No. of facil-ities	Type of waste	Estimated population* equivalent	Type of treatment or disposal
60	Industrial	140,725	Connect to municipal system having primary facilities
2	Industrial	DNA 4/	Connect to municipal system having primary facilities
6	Industrial	30,280	Chemical precipitation
8	Industrial	26,200	Sedimentation, biological oxidation
12	Industrial	192,175	Biological oxidation
15	Industrial	208,310	Chemical coagulation, sedimentation
1	Industrial	3,000	Coagulation, sedimentation, biological treatment
3	Industrial	2,279,000	Control discharges; lagoons (pulp mill); coagulation; sedimentation or flotation (paper mill); nitrate treatment (river)
1	Industrial	210,000	Coagulation, sedimentation or flotation for paper and ground wood wastes, evaporation for waste sulfite liquors
8	Industrial	3,712,000	Sedimentation or flotation for paper and ground wood wastes, lagoons for sulfite liquors
3	Industrial	36,500	Sedimentation or flotation
9	Industrial	197,760	Heat coagulation, screening dewatering, drying, biological filtration
14	Industrial	360,350	Heat coagulation, screening, dewatering, drying
3	Industrial	45,000	Chemical precipitation; haul stack for silage
13	Industrial	7,405	Screens, sedimentation
7	Industrial	29,765	Lagoons; nitrate treatment

Table 23 (Continued)

No. of facil-ities	Type of waste	Estimated population* equivalent	Type of treatment or disposal
9	Industrial	35,800	Fine screens; lagoons
1	Industrial	4,300	Haul whey for animal feed
7	Industrial	3,430	Dilution (regulated discharge)
1	Industrial	DNA 4/	Neutralization; oil separation; metal precipitation; coagulation and sedimentation of cyanides

* Based on biochemical oxygen demand.

1/ One facility will serve two communities.

2/ Five facilities will serve 13 communities.

3/ Population figures for two Air Force Bases not available.

4/ DNA - population equivalent based on biochemical oxygen demand does not apply; N - undetermined.

40. Reduction in pollution load. - Under the provisional pollution control plan for Subregion "A," treatment and disposal facilities would result in a reduction of approximately 30 percent of the present pollution load or a population equivalent of about 2,449,000 persons. Sewage treatment facilities would remove a population equivalent of some 262,000 persons, nearly half the present sewage pollution load. Industrial waste treatment facilities would remove a population equivalent of about 2,187,000 persons, about 26 percent of the present industrial waste pollution load. In addition to a reduction in pollution load by treatment, the provision of adequate storage lagoons for waste sulfite liquors during critical stream flows, the addition of nitrates to receiving streams, and the discharge of waste sulfite liquors from

lagoons during favorable periods of stream flows and temperatures would result in marked improvement in receiving streams. However, there would be little reduction in the total pollution load eventually discharged as a result of the latter measures.

41. Approximate water quality improvement. - With the treatment shown under the provisional pollution control plan for Subregion "A," it is estimated that approximately 900 miles of watercourse would be improved for higher uses than are possible under present conditions of pollution. These miles of improved watercourse represent about 93 percent of the present significantly polluted stretches of streams in Subregion "A." Seventy miles of watercourse would be improved to a very high quality and these waters would become suitable for any water use; 403½ miles would be of a high quality acceptable for any water use except public water supply unless filtered and disinfected; and 427 miles would be of a good quality suitable for such uses as recreational boating, habitat for wildlife and common food and game fishes indigenous to the region; irrigation of crops consumed after cooking and a number of industrial purposes without treatment. Under the provisional plan, all of the 72 miles of watercourses in nuisance condition during critical periods under present pollution loads would be improved, most to a degree suitable for many legitimate purposes.

42. In addition to the streams that would be improved by the provisional plan, eight lakes and ponds and a large number of coastal coves, bays and harbors would be improved. With the exception of

small areas in two lakes, fresh water impoundments would become suitable for any water use, although some would require filtration and disinfection before use as public water supplies. Along the coast, economically important salt water areas would become suitable for development of bathing areas and many of the presently closed clam flat areas could be re-opened, although this would need to be substantiated by bacteriological tests.

43. Table 24 summarizes the approximate effects of the provisional pollution control plan on water conditions in Subregion "A" with respect to suitability of the waters for use. Data are presented by basin or area and show the miles of main stems of streams transporting pollution.

Table 24 - Approximate effects of provisional pollution control plan on water conditions, Subregion "A"

	Approximate present water condition in miles					Approximate water condition under provisional plan in miles					Net water quality improvement in miles			
Basin or area	I	II	III	IV	V	I	II	III	IV	V	I	II	III	IV
Saint John River	254	58	66	87	4	283	99	71	16	0	29	70	71	-
St. Croix River	43	0	9	16	0	43	23	2	0	0	-	23	2	-
Penobscot River	191	102	50	59	45	191	135	121	0	0	-	33	89	-
Kennebec River	252	43	53	148	15	293	61	157	0	0	41	52	146	-
Androscoggin River	7	84	73	159	0	7	158	110	48	0	-	74	98	-
Presumpscot River	28	0	13	2	8	28	13	10	0	0	-	13	10	-
Saco River	7	141	36½	5	0	7	180½	2	0	0	-	39½	2	-
Maine Coastal	0	359	80	31	0	0	458	12	0	0	-	99	9	-
Totals	782	787	380½	507	72	852	1127½	485	64	0	70	403½	427	-

ESTIMATED COSTS FOR POLLUTION CONTROL PROJECTS

44. Estimated construction costs for provisional pollution control. - Based on the sewage and industrial waste treatment projects summarized in Table 23, the total construction cost for the provisional pollution control plan for Subregion "A" has been estimated to total approximately $40,846,000. Of this total, the construction cost of public sewage treatment projects, which includes those for public schools and State and Federal installations, accounts for an estimated $27,480,000. Private sewage treatment and disposal projects to serve individuals, factories and private institutions and schools would cost approximately $1,031,000. Industrial waste treatment and disposal facilities would cost an estimated $12,335,000.

45. Annual charges for public sewage treatment projects. - Based on the estimated construction cost of $27,480,000 and an amortization period of 30 years at $2\frac{1}{2}$ percent, the total capital cost for publicly financed sewage treatment and disposal projects would be an estimated $39,390,000. The annual capital charge during the amortization period would then be approximately $1,312,300. Operation and maintenance costs over this period are estimated to average about $1.88 per capita served for an approximated average of 535,500 persons or an annual total of about $1,015,700. The total annual charge for construction, operation and maintenance of public sewage treatment and disposal projects would then be an estimated $2,328,000.

46. <u>Annual charges for private sewage treatment projects.</u> - The total construction cost for subsurface disposal systems, other treatment facilities and connections to municipal sewage systems to serve significant sources of sewage pollution from private sources has been estimated to be $1,031,000. Based on this estimate and an amortization period of ten years at 4 percent, the total capital cost for such projects would be approximately $1,268,000 and the annual charge would be about $126,800. Based on an average of four persons per household disposal unit and an annual maintenance charge of $10 per household unit and $100 per year for units serving factories and private schools and institutions, the total annual maintenance charge for private sewage facilities would be approximately $29,550. The total annual charge for construction and maintenance of private sewage treatment and disposal facilities for Subregion "A" would then be about $156,350 for ten years.

47. <u>Annual charges for industrial waste treatment projects.</u> - The total estimated construction cost for industrial waste treatment and disposal projects is approximately $12,335,000. This amount amortized over a period of ten years at 4 percent would represent a total capital cost of $15,208,000 and an annual charge of $1,521,000 for ten years. From a consideration of the size and types of treatment projects in the provisional plan for Subregion "A," the annual operating and maintenance costs are estimated to total about $590,000. The total annual charge for construction, operation and

maintenance of provisional industrial waste treatment and disposal projects is an estimated $2,111,000 for ten years.

48. The annual charges for sewage treatment will vary, of course, with each individual municipality. In general the per capita cost for new construction will be highest for small communities and will decrease with increasing populations to be served. Further, the final costs for municipal sewage treatment will depend in large measure on the industrial wastes to be intercepted, choice of plant design, construction materials and equipment specified and the method of financing. Annual charges for industrial waste treatment will also vary with each individual manufacturing plant. Final costs will largely be determined by in-plant changes required, the volume and character of wastes to be treated, choice of treatment plant design and the construction materials and equipment specified.

49. Public sewage treatment projects are considered as those which would be financed by public funds and private sewage and industrial waste treatment projects as those to be financed by private capital. Table 25 summarizes the estimated construction costs and annual charges for the provisional pollution control plan for Subregion "A."

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Table 25 - Summary of estimated construction costs* and annual charges for provisional treatment and disposal facilities, Subregion "A"

Pollution to be served	Estimated construction cost	Estimated annual capital charge 1/	Estimated annual operation and maintenance charge	Total estimated annual charge 1/
		SAINT JOHN RIVER BASIN		
Municipal sewage	$ 1,350,000	$ 64,500	$ 42,500	$ 107,000
Private sewage	52,000	6,400	1,600	8,000
Industrial wastes	1,320,000	163,000	110,000	273,000
TOTALS	2,722,000	233,900	154,100	388,000 2/
		ST. CROIX RIVER BASIN		
Municipal sewage	310,000	14,800	11,200	26,000
Private sewage	9,000	1,100	250	1,350
Industrial wastes	1,250,000	154,000	68,000	222,000
TOTALS	1,569,000	169,900	79,950	249,350 2/
		PENOBSCOT RIVER BASIN		
Municipal sewage	3,520,000	168,000	143,000	311,000
Private sewage	50,000	6,200	1,800	8,000
Industrial wastes	1,760,000	217,000	80,000	297,000
TOTALS	5,330,000	391,000	224,800	616,000 2/
		KENNEBEC RIVER BASIN		
Municipal sewage	4,415,000	211,000	168,000	379,000
Private sewage	300,000	37,000	9,000	46,000
Industrial wastes	2,890,000	356,000	125,000	481,000
TOTALS	7,605,000	604,000	302,000	906,000 2/
		ANDROSCOGGIN RIVER BASIN		
Municipal sewage	4,196,000	200,000	180,000	380,000
Private sewage	151,000	18,600	3,400	22,000
Industrial wastes	3,253,000	401,000	120,000	521,000 3/
TOTALS	7,600,000	619,600	303,400	923,000 2/

Table 25 (Continued)

Pollution to be served	Estimated construction cost	Estimated annual capital charge 1/	Estimated annual operation and maintenance charge	Total estimated annual charge 1/
		PRESUMPSCOT RIVER BASIN		
Municipal sewage	$ 696,000	$ 33,000	$ 27,000	$ 60,000
Private sewage	45,000	5,500	1,500	7,000
Industrial wastes	1,029,000	127,000	24,000	151,000
TOTALS	1,770,000	165,500	52,500	218,000 2/
		SACO RIVER BASIN		
Municipal sewage	1,543,000	74,000	60,000	134,000
Private sewage	73,000	9,000	2,000	11,000
Industrial wastes	540,000	67,000	25,000	92,000
TOTALS	2,156,000	150,000	87,000	237,000 2/
		MAINE COASTAL AREA		
Municipal sewage	11,450,000	547,000	384,000	931,000
Private sewage	351,000	43,000	10,000	53,000
Industrial wastes	293,000	36,000	38,000	74,000
TOTALS	12,094,000	626,000	432,000	1,058,000 2/
		GRAND TOTALS 2/ SUBREGION "A"		
Municipal sewage	$27,480,000	$1,312,300	$1,015,700	$2,328,000
Private sewage	1,031,000	126,800	29,550	156,350
Industrial wastes	12,335,000	1,521,000	590,000	2,111,000
TOTALS	$40,846,000	$2,960,000	$1,635,250	$4,595,350 2/

* Based on 1949 Engineering News-Record construction cost index.

1/ Based on amortization periods of 30 and 10 years at 2½ and 4 percent interest respectively for public and private construction.

2/ Total applies only during 10-year amortization of industrial waste and private sewage treatment costs.

3/ If the estimated cost of $2,150,000 for in-plant changes at all industrial plants is included the total annual charge for industrial waste treatment in the Androscoggin River Basin would be $786,000 for 10 years. If the estimated costs for in-plant changes at industrial plants in the other river basins were included, the total annual charges for industrial waste treatment would be similarly increased.

BENEFITS RESULTING FROM WATER QUALITY IMPROVEMENT

50. Benefits resulting from pollution control may be both tangible and intangible. A tangible benefit would be represented by a direct savings in costs for water treatment for public or industrial water supply as a result of pollution control. Another example of a tangible benefit would be recovery of valuable by-products in the process of reducing pollution. Intangible benefits are those which do not readily lend themselves to computation in monetary terms. Protection of the public health, abatement of nuisance conditions and enhanced aesthetic values through pollution control are examples of intangible benefits. For the most part, benefits assigned to pollution control are intangible, largely through the absence of suitable criteria for monetary evaluations. There are occasions, however, where suitable data are available when tangible benefits from pollution control can be computed on a monetary basis, although such data are not available for Subregion "A."

51. Benefits that may accrue from water quality improvement through pollution control depend upon the uses the improved water resource will serve. There are also potential benefits through the conservation of water resources for future use. In Subregion "A," the water resources serve as public water supplies, industrial water supplies, agricultural water supplies, for all types of recreation, as a habitat for fish and wildlife, for transportation of forest products to mills, for power development, for navigation and for

transportation of sewage and industrial wastes. Save the last four which do not require a good water quality, these water uses are the ones potentially to be benefited by pollution control.

52. There is an appreciable number of benefits that could accrue from pollution control as a result of improving the waters of the sub-region for their highest best use. From a consideration of the present economy and the stream improvements that could be effected through pollution control, the following benefits could result if the water resources are developed for the purposes for which they are best suited. In the absence of suitable criteria, no monetary evaluations are made and although presented as intangible, these benefits have been proven through the years as most desirable and worthy of attainment. For the most part, they have been the basis for investment of millions of dollars in existing sewage and industrial waste treatment facilities in other areas that have been constructed to serve the best interests of the public.

a. There could be a significant benefit to the public health by reducing the chances for waterborne diseases by the treatment of, or elimination of municipal, institutional and industrial sewage pollution. Sewage polluted waters are always a potential health menace.

b. Large volumes of readily accessible water at desirable industrial sites could be made suitable for and attractive to new industrial development that could result in increased income and economic stability in the subregion.

c. The construction of the needed municipal sewage treatment works could make the communities served more attractive to new industries requiring this municipal utility which could be of real significance to local economies.

d. Some of the industries now dependent on low quality waters for process purposes may realize significant savings in present costs for water treatment from water quality improvement.

e. A number of industries now discharging industrial wastes may realize significant savings through recovery of valuable by-products and greater utilization of raw materials.

f. Industrial, residential and recreational real estate now located on or dependent on waters presently receiving pollution could be made more desirable and, thereby, appreciably increased in value when pollution is abated.

g. Pollution abatement may make large areas of land and water resources suitable for greater development by the recreation industry and could thereby, add to the income and economic stability of the subregion by an increased tourist and vacation trade.

h. Control of pollution could protect and enhance the extensive ocean frontage recreation development and could contribute substantially towards insuring the continued income from this economically important industry.

i. Pollution control could permit the re-opening of the extensive clam flat areas now closed because of pollution and could result in significant increased income to the shellfish industry.

j. Farms not using streams because of pollution could have these water resources available for most of all agricultural purposes.

k. Industries contributing to damages to water resources could experience a worthwhile benefit from improved public relations through abatement of pollution for which they are responsible.

l. Aesthetic nuisances and unsatisfactory water conditions created during periods of low flows and high temperatures could be eliminated or alleviated.

m. The general welfare of the people could be enhanced by the conservation of a vital natural resource for its best uses and by a greater opportunity to benefit therefrom. Further, clean streams could enhance the general reputation of the subregion in the eyes of visitors and vacationists.

53. Resource development and benefits. - There is, of course, a direct inter-relation between water resource development and benefits from pollution control. The more extensive and varied water use becomes the more benefits can be obtained from pollution control to maintain the necessary water qualities for the purposes served. Should further development of Subregion "A" be undertaken with an integrated plan, it could result in a significant increase in industrial and recreational development which would be accompanied by an

increase in population. These developments would appreciably enhance the value of the water resources for public water supply, industrial water supply and recreation. Land abutting on or served by water resources suitable for industrial, residential and recreational use would also be increased in value. Pollution control measures to maintain acceptable water qualities under these circumstances would produce benefits in proportion to the magnitude of the economic development.

EVALUATION OF MONETARY BENEFITS OR LOSSES TO POLLUTION CONTROL FROM THE CONSTRUCTION OF CONSERVATION AND DEVELOPMENT PROJECTS

54. Details of evaluations of projects studied in Subregion "A" are given in each Section V of Chapters III through X. These evaluations show that no benefits or losses would accrue to pollution control from construction of conservation and development projects except in the Androscoggin River Basin. The evaluation of projects in the Androscoggin River Basin is too detailed for summarization and reference is made to paragraphs 96 through 113 in Section V of Chapter VII.

SECTION VI - FLOOD CONTROL AND DRAINAGE

GENERAL PROBLEMS

1. Flooding in Subregion "A" occurs almost annually as the result of heavy spring rains which often fall when snow is melting and river ice is breaking-up, producing major problems in the Penobscot, Kennebec, Androscoggin and Saco River Basins. The annual flood losses are greatest in the Kennebec Basin, and average $210,000 annually at 1949 price levels. Only in rare instances are heavy rains alone responsible for major floods. The subregion is generally forested and contains extensive areas of lakes, ponds, and swamps which tend to retard flood run-off. Occasional flash floods occur on the tributaries but usually have little effect on main stream flows.

2. Erosion problems are generally confined to open farm land. Sheet erosion is in evidence throughout the inhabited portion of Subregion "A". Flood and erosion problems have been intensified by past land use and management. The type of management has resulted in the deterioration of watershed protective cover, in loss of soil, in increased run-off, and flood damages. A change in land management practices, supplemented by rehabilitation of critical flood and sediment source areas is needed in Subregion "A" to correct the present unsatisfactory watershed conditions and reduce surface run-off and erosion.

HISTORY AND ANALYSIS OF FLOODS

3. Flood history. - The first recorded instance of major flooding in Subregion "A" occurred in 1785 on the Androscoggin and Saco Rivers. A lesser flood occurred on the Androscoggin River in February 1723. Following paragraphs are excerpts from U. S. Geological Survey Water Supply Paper No. 798, "Flood of 1936" which contain a section based on state histories, papers in town libraries, and other sources:

a. "Androscoggin River, 1723 February. - This is the earliest freshet on the Androscoggin River to which any reference has been found. At this time the ice went out of the lower 30 miles of the river with probably no damage."

b. "Androscoggin River, 1785, October 22. - Lapham's History of Bethel, Maine, states that the Androscoggin River at Bethel rose to the highest stage ever known, 25 feet above normal. Investigations during 1936 indicate that this statement is probably correct and that the stage reached at Bethel was 1.5 feet higher than that of March 1936. Log jams may have affected the stage of the flood of 1785. Wheeler's History of Brunswick, Maine, published in 1878, states that the loss at Brunswick included one sawmill, two gristmills, one fulling mill, and three houses."

c. "Saco River, 1785 October. - This freshet on the Saco River was caused by a three-day rainfall in southwestern Maine and in southeastern New Hampshire, the rainfall being as much as nine inches in some places. Both spans of the bridge between Saco and Biddeford, Maine, were carried away, also many bridges, houses, and mills in the upper reaches of the rivers. Williamson's History of Maine contains the following statement with reference to this flood: 'It was in this section of the district that the uncommon freshet in October did such universal damage. Two days and two nights it rained without cessation, as powerfully as ever known. The water in the river, rising to a fearful height, swept away bridges and mills and otherwise made such destruction that seven towns the next year had their taxes to the amount of 530 pounds abated by the General Court.'"

4. Data for some of the recorded major floods experienced in Subregion "A" are shown in Table 26 with dates and magnitudes of these floods.

5. Major floods in Subregion "A" are usually due to a combination of heavy rainfall and melting snow in the spring of the year. The stages in such spring floods are frequently increased at various locations by the formation of ice jams. Floods attributable to heavy rainfall alone may be expected to occur infrequently at other times of the year.

6. Flood storms. - A definite combination of meteorological conditions is recognized as being responsible for most of the great flood-producing storms in the northeastern United States. The conditions are (1) a persistent high-pressure area over the western North

Table 26 - Major floods, Subregion "A"

Date	Location	Drainage area (Sq.Mi.)	Period of record	Discharge 2/ (c.f.s.)	Remarks
		SAINT JOHN RIVER BASIN			
May 1923	Van Buren,Me.	8,260	1908-1928	135,000	
May 1923	Ft. Fairfield,Me.	2,290	-	1/	Flood of record not affected by ice; similar stages experienced 3 times since 1923 due to ice jams.
May 1933	Ft. Kent,Me.	5,690	1926-1953	121,000	Highest stage of record.
		ST. CROIX RIVER BASIN			
May 1923	Baileyville,Me.	1,320	1919-1953	23,300	Flood of record.
Apr.1950	Baileyville,Me.	1,320	1919-1953	19,500	
Dec.1950	Baileyville,Me.	1,320	1919-1953	19,900	
		PENOBSCOT RIVER BASIN			
Apr.1901	West Enfield,Me.	6,600	1901-1953	115,000	
May 1923	West Enfield,Me.	6,600	1901-1953	153,000	Flood of record.
Mar.1936	West Enfield,Me.	6,600	1901-1953	125,000	
Apr.1940	West Enfield,Me.	6,600	1901-1953	113,000	
		KENNEBEC RIVER BASIN			
Dec.1901	Waterville,Me.	4,200	1892-1953	157,000	Flood of record.
May 1923	Waterville,Me.	4,200	1892-1953	135,000	
Mar.1936	Waterville,Me.	4,200	1892-1953	154,000	

Table 26 - (Continued)

Date	Location	Drainage area (Sq.Mi.)	Period of record	Discharge 2/ (c.f.s.)	Remarks
		ANDROSCOGGIN RIVER BASIN			
Apr.1895	Rumford,Me.	2,067	1892-1953	55,230 3/	
Mar.1936	Rumford,Me.	2,067	1892-1953	74,000	Flood of record.
Mar.1953	Rumford,Me.	2,067	1892-1953	56,700	
		PRESUMPSCOT RIVER BASIN			
Apr.1902	Outlet Sebago Lake,Me.	436	1887-1951	7,000	Flood of record.
Apr.1936	Outlet Sebago Lake,Me.	436	1887-1951	3,780	
		SACO RIVER BASIN			
Mar.1936	West Buxton,Me.	1,572	1907-1953	58,100	Flood of record in: lower reaches.
Mar.1953	West Buxton,Me.	1,572	1907-1953	50,000	headwater areas.

NOTE: There are no definite records of past floods in the Maine Coastal Area.

1/ Not known.
2/ Instantaneous unless otherwise noted.
3/ Daily.

Atlantic Ocean with its clockwise air circulation supplying moisture-laden air; (2) a second high-pressure area over the mid-continent; and (3) a low-pressure trough between these "highs" where the strong convergent air flow lifts moist air over the cold air and produces copious rainfall.

7. During the period, March 9-22, 1936, there occurred in close succession over the northeastern United States from Virginia and Pennsylvania to the river basins in Maine, two heavy rain storms. At the time of the rain there was an above normal accumulation of snow on the ground in Maine which, under the influence of the warm temperatures associated with the storms, thawed and supplied additional water to be carried by the rivers. The two rain storms produced two distinct flood peaks and, at many locations, the flooding was aggravated, especially during the first peak, by the break-up and jamming of thick ice cover built up during the previous exceptionally severe winter. The floods of record for most of the Penobscot, Kennebec, Androscoggin, and Saco River Basins were produced by these storms.

8. In addition to the generalized storms, localized storms of the cloudburst type (intense rainfall on very small areas, usually associated with thunderstorms) occur on rare occasions in Maine. Such storms can cause destructive floods on small brooks and streams. The most notable example of this type occurred in August 1939 in the Town of Baldwin, Maine--Saco River Basin. The intense rain was limited to about 30 square miles with up to 12 inches of rain falling in about three hours.

9. Land management. - In many areas land management practices of the past have contributed to the rapid run-off of flood waters. Some of the agricultural land has been overcropped, pastures have been overgrazed and farm forests have been inadequately managed and damaged by grazing. Forests have been clearcut and the cutover areas have been burned and reburned. Logging roads and skid trails have been constructed without due regard to the resulting run-off and erosion. These practices have adversely affected the hydrologic characteristics of the subregion.

10. Data on flood flows. - Flood data are available from published records at 52 stream-gaging stations, some of which have been in operation for various periods of time since 1887 on the main rivers and tributaries in Subregion "A". Additional information on stream flow is contained in Section I of Chapters II through X.

11. Analysis of floods. - The flood producing potentialities and characteristics of the Penobscot, Kennebec, Androscoggin and Saco River Basins were determined from data obtained during three floods experienced in each of these basins. The dates of the floods which were analyzed in detail for each of these basins are listed in Table 27.

Table 27 - Floods analyzed, Subregion "A"

Penobscot R. Basin	Kennebec R. Basin	Androscoggin R. Basin	Saco R. Basin
Mar. 1936	Mar. 1936	Mar. 1936	Mar. 1936
Nov. 1950	Nov. 1950	Nov. 1950	May 1940
Nov. 1943	April 1951	June 1942	Mar. 1953

12. For the purposes of hydraulic analyses, the main rivers in these basins were divided into reaches with limits at the mouths of their principal tributaries and at hydraulic control points such as existing gaging stations and dams where flow could be computed. For the three floods analyzed in detail in each basin, observed hydrographs were utilized where available. Synthetic hydrographs were developed for all ungaged areas by study of the rainfall distribution, snow cover pattern, and the run-off hydrographs from comparable gaged areas. The flood hydrographs from the tributaries, in each of the basins, were routed downstream to determine the tributary contribution to main river peaks, allowances being made for the travel, the character of the reach, the amount of the intervening inflow, and the relative timing of the peak flows.

13. From a study of the data obtained in these four basins, it has been determined that:

a. In the Penobscot River Basin, the principal contributors to floods on the lower reaches of the main Penobscot River are the Piscataquis, Mattawamkeag, and the East Branch Penobscot Rivers. The chief flood-producing areas in the Piscataquis River Basin are the Pleasant River Basin and the watershed of the Piscataquis River above Dover-Foxcroft.

b. In the Kennebec River Basin, the major sources of floods on the lower Kennebec River are the Carrabassett and Sandy Rivers. Austin Stream is also a high contributor considering its relatively small drainage area. The Lead and Sebasticook Rivers are of less importance in the development of floods. The flood run-off from the 1,240 square miles in the upper region of the basin is influenced considerably by the large amount of storage and regulation afforded by Moosehead Lake. This area, representing approximately 30 percent of the watershed above Waterville, makes a negligible contribution to the peak flows at all locations along the main river.

c. In the Androscoggin River Basin, the following tributaries, in downstream order, are the principal sources of floods on the lower Androscoggin River: the Moose, Peabody, Wild, Ellis, Swift, Nezinscot, and Little Androscoggin Rivers. The Nezinscot and Little Androscoggin Rivers, with an aggregate drainage area of 540 square miles, have been major contributors to flood flows on the lower Androscoggin River. The smaller Ellis and Swift Rivers, together draining 288 square miles of mountainous watersheds, have contributed almost as much to the flood peaks at Auburn as the combined flows from the Nezinscot and Little Androscoggin Rivers.

d. In the Saco River Basin, the maximum rates of discharge per square mile in the headwaters of both the Ossipee and Saco Rivers are considerably greater than occur further downstream. The various tributary and local contributions to the flood peaks at downstream points, however, are approximately proportional to their drainage areas due to the equalizing effect of valley storage and the relative timing of the various tributary inflows. An outstanding physical characteristic of the Saco River Basin is the unusually large flood plain extending upstream from the village of Hiram, Maine, to approximately the New Hampshire state line. This area acts as a very effective flood retarding basin and has a marked modifying influence on all flood discharges. Similarly, the surcharge storage in Ossipee Lake, in New Hampshire, also acts as a natural flood retarding basin.

14. In the Saint John, St. Croix, and Presumpscot River Basins, and in the Maine Coastal Area, floods have been relatively infrequent and are a less important problem. Minor flooding is frequently experienced during the annual rise in the rivers caused by spring run-offs. Further details on flood analysis in these four basins follow:

a. In the Saint John River Basin the largest contributors to floods at Fort Kent are the upper Saint John River above Dickey, Maine, and the St. Francis River. The Allagash, Fish, and Madawaska Rivers have considerable lake storage in their headwaters which tend to reduce their flood producing potentialities. The Tobique and Aroostook Rivers lack extensive natural storage areas in their middle and lower reaches and therefore contribute substantially to peak flood flows on the lower Saint John River.

b. In the St. Croix River Basin the floods of 1923 and 1936 were caused by heavy rains falling on a snow-covered watershed. These floods were not particularly damaging. The 1,320 square miles of drainage area above the Grand Falls Dam, equivalent to about 90 percent of the basin area above Calais, contain extensive areas of lakes, ponds, and swamps which act as retarding basins for the run-off in the event of heavy rains. The comparatively flat topography of this area also tends to prevent rapid run-off.

c. In the Presumpscot River Basin the series of lakes and ponds above the outlet of Sebago Lake affords almost complete control of over 70 percent of the total area of the watershed and thus provides a high degree of protection to the lower basin. The uncontrolled area of 212 square miles below Sebago Lake is not sufficiently large nor the run-off rapid enough to produce damaging flood flows in the river.

d. In the Maine Coastal Area the problem on the Narraguagus River is primarily one of ice jams that have been experienced since the disappearance of the last of the five small dams at Cherryfield, Maine. In general, the comparatively flat topography of the area, with its numerous lakes, ponds and swamps, tends to cause the run-off to be relatively sluggish.

DAMAGES

15. Flood damages. - From the discussion in paragraph 6 it will be noted that in Subregion "A" storms which produce major floods effect damages in areas larger than a single river basin. The simultaneous occurrence of floods in several river basins disrupts transportation. Access between localities separated by flooded areas involves extensive detours which are often two to three times as long

as the customary route. In the major floods such as 1901, 1923, and 1936 railroad transportation was curtailed for periods of from one to two weeks. These major floods also caused shutdowns of damaged industrial plants and delays in shipment of products from the area. At the same time incoming shipments of raw materials such as cotton, wool, and leather were delayed until repair of flood damages was effected. In the instance of the 1936 storm, which also flooded the Merrimack and Connecticut River Basins, suppliers and distributors in other sections of the nation were adversely affected by the slow-down of supplies from New England.

16. The estimated flood damages, for the more recent major floods in Subregion "A", and the estimated average annual damages which would be occasioned by a recurrence of 1936 flood stages are shown in Table 28.

Table 28 - Estimated flood damages, by basins, Subregion "A"

Basin	Experienced flood damages 1923	1936	1953	Average annual recurring damages (1949 price level)
Saint John River	No Data	No Data	No Data	No Data
St. Croix River	$ 50,000	No Data	No Data	No Data
Penobscot River	1,300,000	$ 369,000	$ 220,000	$ 92,500
Kennebec River	No Data	1,631,000	710,000	209,400
Androscoggin River	No Data	4,392,000	2,230,000	153,500
Presumpscot River	No Data	No Data	No Data	No Data
Saco River	No Data	1,610,000	1,800,000	178,700
Maine Coastal Area	35,000 1/	20,000 1/	No Data	No Data

1/ These figures represent only the damages sustained at Cherryfield, Maine.

17. Headwater damages. - Headwater flood damages were estimated for agricultural crops, for other agricultural resources and for urban, residential and industrial facilities. Average annual damages were estimated for sample tributaries and projected to each area on a per square mile basis. Estimates were made of the losses that would occur at flood stages above and below a flood of record. In determining agricultural crop losses by stage, the flooded area for each crop was first related to flood stages. Per acre crop values, modified to reflect monthly variations in crop values and the percent chance of flood occurrence by months, were then applied to the area

of each crop inundated at various stages to develop stage-crop loss relationships. Stage-damage relationships for all types of damageable values were converted to damage frequency curves in accordance with the methods outlined in Part Three of the report. The total estimated annual loss for the headwater areas in Subregion "A" was found to be $91,300 at 1949 price levels. Figures for headwater damages also include areas along the main streams which have only minor damages.

18. Main stream and tributary damages. - Studies of the flood problems were made in six basins of Subregion "A". A detailed review of flood damages in these basins was made in 1951 and 1952. All major items of probable damage were investigated, including industrial properties, commercial establishments, highways, bridges, railroads, and utilities, with a view to determining the present extent of development and use and the extent of damage that would be sustained in the event of future floods. The main rivers and tributaries were divided into damage zones and the estimated losses at various stages of flooding, for each item of damage, were summarized to arrive at a stage-damage curve for each zone. The curves of stage-damage were correlated with stage-discharge and discharge-frequency relationships to develop curves of damage-frequency. The area under these latter curves gave the estimated annual loss for each zone. The total estimated annual loss for all the main stream and tributary damage zones in Subregion "A", determined by summating figures for individual

zones, was found to be $681,800 at 1949 price levels. Figures for St. Croix and Presumpscot River Basins are not included in this estimate as these were not available.

19. Erosion damages. - Erosion damages on cropland were determined by estimating the rate of soil loss and the average annual reduction in yield due to erosion. Erosion losses are especially severe in the Saint John Valley in Aroostook County where potatoes are grown on sloping land. Application of the yield reduction data and the effective soil loss rate indicates that the average annual equivalent value of the loss in Subregion "A" over a 30-year period at 4 percent discount rate is $547,200 at 1949 price levels. A full description of the calculation is given in Part III of the report.

20. Sedimentation damages. - Each year some land, especially on steep slopes, or recently plowed land, suffers erosion in times of severe storms, and the eroded material may reach highways, drainage ditches and streams. The sediment produced by erosion may cause an amount of damage reflected in additional costs necessary to clean highway culverts, protect bridges and maintain navigation channels. These maintenance costs are such a small percentage of the total that accounts do not show them separately. Monetary evaluation of sedimentation damage has not been included in damage totals.

21. Sedimentation of water supplies is not a serious problem in Subregion "A" although some costs are incurred in the Penobscot,

Kennebec, Androscoggin, and Saco River Basins to reduce sediment in domestic water supplies. There are insufficient data available to permit preparing an accurate estimate of the cost of sediment removal.

22. Total damages. - Total average annual flood and erosion damages amounting to $1,320,300 are summarized in Table 29.

Table 29 - Average annual flood and erosion damages, (1949 price levels), Subregion "A"

	Floodwater damages		Erosion damages	Total annual damages
	Headwater areas	Main stream and tributary damage zones	Cropland erosion 1/	
Saint John River	$12,000	$ 47,700	$412,000	$ 471,700
St. Croix River	2,800	- 2/	2,700	5,500
Penobscot River	17,400	92,500	74,000	183,900
Kennebec River	16,300	209,400	14,600	240,300
Androscoggin River	9,300	153,500	16,300	179,100
Presumpscot River	Negligible	Negligible	2,100	2,100
Saco River	7,300	178,700	4,600	190,600
Maine Coastal Area	26,200	- 2/	20,900	47,100
TOTAL annual damages Subregion "A"	$91,300	$681,800	547,200	$1,320,300

1/ These figures represent only the net loss of income from yield decline due to sheet erosion.

2/ Damage zones not established in this basin.

NEEDS

23. Subregion requirements. - The average annual damages in the subregion, which total $1,320,300, indicate a need to consider flood protection and erosion control measures to reduce losses. At the hearings of the Committee at Augusta, Maine and Concord, New Hampshire, no specific requests were made for flood protection or erosion control measures in the basins comprising Subregion "A". General requests for erosion control measures were made at both hearings.

PLANS OF IMPROVEMENT

24. Existing flood control improvements. - There are no Federal flood control projects in Subregion "A". Local interests have constructed protection works at a few locations in some of the basins, but these works are strictly of a limited nature. In a few instances private companies have adopted plans of operation to minimize future damages by removing goods and equipment to higher levels when a flood is imminent.

25. The Weather Bureau Office at Portland issues general warnings (of degree of flooding rather than specific stage) to Augusta, Bangor, Rumford, Lewiston, Saco and Biddeford whenever flood stage is anticipated in any of these areas. During the period of greatest flood hazard in the spring, this office issues a bulletin, evaluating the existing flood potential in the State of Maine, for distribution to press and radio. In addition, special warnings of heavy rainfall and

abnormal tidal effects are issued whenever hurricanes or other coastal storms are expected to affect any part of the subregion.

26. <u>Consideration of flood control improvements.</u> - Consideration has been given to the possibilities of reducing flood damages in Subregion "A" by the construction of flood control works. Preliminary investigations of the Saint John River, St. Croix River and Presumpscot River Basins and Maine Coastal Area indicate that the extent of the annual damages in these basins is not sufficient to justify flood protection works. A determination was made of the value of flood control storage in various tributary watersheds of the Penobscot, Kennebec, Androscoggin, and Saco River Basins in order to ascertain the economic justification of flood control reservoirs in those basins. The studies were based on hydrologic analyses and flood damage data. The value of flood control storage is too low to justify the provision of flood control storage in single- or multiple-purpose reservoirs in these basins at this time. The possibilities of providing local protection works for the principal damage centers in the subregion have also been given consideration. Investigations indicated that such projects are not economically justified at this time.

27. <u>Effect of power projects on flood control.</u> - Subregion "A" has a total of 41 projects in the inventory power plans for the basins including 23 run-of-river projects for power development only, five storage projects, and 13 combined power and storage projects. Information on the power projects is shown in Table 34 in Section VII. No

portion of the storage provided in the inventory power plans has been allocated to flood control. Any benefits to flood control from operation of the projects would be incidental to their primary purpose of producing hydroelectric power. The 23 run-of-river projects would have no appreciable storage and would be maintained at or near full pool level at all times for maximum power output. They would afford no beneficial effects on flood flows.

28. Of the 18 inventory power projects containing storage, Rankin Rapids Reservoir on the Saint John River would have considerable beneficial influence on annual flood stages. It would have sufficent capacity to store a large proportion of the spring run-off from the 4,060 square miles of drainage area on the Saint John River above the site. The storage of the Masardis Reservoir would afford some reduction in spring floods on the Aroostook River. Flood damages on these two rivers are relatively minor and the varying amounts of storage available in Rankin Rapids and Masardis Reservoirs to reduce flood stages have not been evaluated.

29. Determinations were made of the relative flood control effectiveness of storage in the Grand Falls and Greenleaf projects in the Kennebec River Basin and the five projects containing storage in the Penobscot River Basin. Measured in dollars, the varying amount of storage available from month to month in the Grand Falls Reservoir would afford average annual benefits from the reduction of flood damages in the amount of $25,100. The storage in the Greenleaf Reservoir would afford benefits averaging $3,100 annually.

30. In the Penobscot River Basin the relative flood control effectiveness of the storage in the Bonnie Brook development was found to be negligible. For convenience of computation, the three inventory projects with storage in the watershed of the East Branch Penobscot River were considered as an integral unit (Allagash Lake, Grand Lake, and Whetstone Falls), and it was found that they would afford average annual benefits from the reduction of flood damages in the amount of $6,300 The storage in the Stratton Rips Reservoir would produce benefits averaging $11,900 annually. The total storage available in these seven reservoirs for reduction of peak discharges would produce benefits averaging $46,400 annually at 1949 price levels. No flood control benefits can be attributed to the other projects in the inventory plans which provide storage in Subregion "A".

31. Effect of land treatment program on floods. - The land treatment measures planned for the primary purpose of securing an optimum level of agricultural production in the subregion would, upon installation, exercise a beneficial effect on the hydrologic characteristics of the subregion. They include adjusting land use with land capability, adoption of improved cropland and forest land management practices, and installation of the necessary minor structures needed to make the land conversions and improved management measures fully effective. A complete description of the land treatment plan is included in Section XI.

32. The beneficial effect of the proposed land treatment program in reducing flood, erosion and sedimentation damages in Subregion "A" is dependent upon three principal variables:

a. Frequency and type of flood producing storms.

b. Acceptance of the program by landowners and the progress which they make to put the various elements of the program into operation throughout the subregion.

c. Continuation of the practices throughout the years after they have once been put into operation.

The full benefits of the program in reducing flood flows would not be felt immediately upon adoption of the program. Instead the benefits would increase with time. From some of the work contemplated in the program, such as small structures, flood flow reduction would begin to accrue as soon as they were constructed; other operations would produce their full benefits within two or three years; from some the full benefit would not be felt for four or five decades. The program would have its maximum effectiveness on floods of the one-year or two-year frequency. It would probably have only a very small effect on major spring floods.

BENEFITS

33. There is no general plan for flood control included in the plans for this subregion. The construction of flood control reservoirs was considered in rivers where total damages indicated a possibility of feasibility, and local protection works such as dikes and

channel improvements were studied at the more promising damage centers, but it was found that the benefits which could be obtained by these flood control measures were not sufficient at any location to justify the cost at this time.

34. Flood control benefits are limited to those benefits incidental to the land treatment measures, to those incidental to the production of hydroelectric power and to the reduction of flood damages by a combination of alert forecasting and local planning for mobilization of flood fighting forces. Benefits from land treatment measures would amount to $638,700 annually in Subregion "A", as summarized, by basins, in Table 30. The annual flood control benefits which would accrue from the storage of water in the operation of power projects in Subregion "A" would amount to $46,400 and are summarized, by project, in Table 31.

Table 30 - Summary of ultimate flood reduction and erosion control benefits incidental to land treatment, (1949 price level), Subregion "A"

Basin	Flood reduction	Erosion 1/ control	Total annual benefits
Saint John River	$1,600	$412,000	$413,600
St. Croix River	300	2,700	3,000
Penobscot River	13,800	74,000	87,800
Kennebec River	20,800	14,600	35,400
Androscoggin River	33,100	16,300	49,400
Presumpscot River	-	2,100	2,100
Saco River	18,300	4,600	22,900
Maine Coastal Area	3,600	20,900	24,500
Total annual benefits, Subregion "A"	$91,500	$547,200	$638,700

1/ These figures represent only the net income benefit from elimination of yield decline due to sheet erosion.

Table 31 - Summary of ultimate flood reduction benefits incidental to production of hydroelectric power, (1949 price level), Subregion "A"

Basin	Project	Annual benefits
Saint John River	Rankin Rapids	$ -
	Masardis	-
Penobscot River	East Branch Projects	6,300
	Stratton Rips	11,900
Kennebec River	Grand Falls	25,100
	Greenleaf	3,100
Total annual benefits, Subregion "A"		$46,400

SUMMARY AND CONCLUSIONS

35. Summary. - Although floods have been frequently experienced in Subregion "A", the flood problem in the subregion is considered to be relatively minor. Large floods, causing serious damage and inconvenience, principally in the Penobscot, Kennebec, Androscoggin and Saco River Basins, occur at relatively infrequent intervals. The extensive amount of natural storage in the subregion especially in the headwater areas, provides a considerable modification of flood flows with a consequent reduction in flood damages. A general plan of flood control works for the sole purpose of reducing flood damages on the main streams in the subregion has not been offered since the costs exceed the estimated benefits at this time.

36. The storage provided in the reservoirs of the inventory power plan would afford some reductions in flood flows at various downstream damage centers in the subregion. However, this storage would not always be dependable for flood control since flood conditions may be experienced at times when the reservoirs are full. It is estimated that the power reservoirs would provide average annual incidental flood control benefits amounting to $46,400 annually at 1949 price levels. Appreciable incidental flood control benefits would be provided by the land treatment measures of the Coordinated Basin Plan. Particularly in urban and industrial areas, an economical reduction of flood damages may be obtained by providing a flood forecasting and warning service, coupled with local plans for evacuation and other

protective measures to be taken on the basis of such forecasts and warnings. In areas where there is a very short time interval between onset of rainfall and ensuing flood, it is possible to train a local representative in procedures for issuing warnings based on a special river and rainfall network reporting to him.

37. Fertile soil is steadily being destroyed by erosive action. Erosion occurs on sloping cropland and on poorly constructed logging roads and skid trails for logging operations. Sheet erosion is quite extensive on the sloping cropland in Subregion "A", especially in the Aroostook Valley of the Saint John River Basin where the major crop is potatoes. Eroded soil moves into streams, clogs road drainage facilities, and increases water treatment costs. A great portion of the annual erosion and sedimentation damages would be eliminated by installation of the land treatment measures described in Section XI.

DRAINAGE

38. There are no major drainage problems in Subregion "A". There are nine problem areas in the subregion, which investigations and studies indicate are susceptible to improvement through local farm drainage. These would involve no major drainage outlets. These problems are considered in Section XI, Land Management.

SECTION VII - POWER DEVELOPMENT

EXISTING AND UNDEVELOPED WATER POWER

1. General. - The aggregate capacity of the existing water power plants in Subregion "A" at the close of the year 1953 was about 450,000 kilowatts. The undeveloped hydroelectric power resources of the Subregion are estimated to amount to about 1,236,000 kilowatts. It therefore appears that the total water power resources of Subregion "A", may be taken as nearly 1,700,000 kilowatts of which about 26 percent is at present (1953) developed. The estimate of undeveloped potential is based upon practical realistic criteria of engineering and an apparent degree of economic feasibility, including considerations as to lower limit in size of project, project costs and benefits and effects of new projects upon facilities now existing. All considered projects having a benefit-cost ratio of about 0.60 to 1 or more under private financing comprise the above estimate of undeveloped water power. The undeveloped potential of tidal power at Passamaquoddy Bay is not included in the estimate.

2. Existing hydroelectric development. - Of the 450,000 kilowatts already developed approximately 277,000 kilowatts or 62 percent are accounted for by utility installations. The 60 plants in this classification are capable of producing annually about 1,333 million kilowatt-hours, reflecting a capacity factor of 55 percent. The remainder of the existing water power comprises about 175,000 kilowatts of capacity in 55 stations operated by non-utility

enterprises, chiefly industrial establishments. These facilities have an average annual output of about 879 million kilowatt-hours, reflecting an annual capacity factor of 59 percent. In addition to the foregoing existing developments there were under construction at the close of 1953 one utility project with an aggregate capacity of 75,000 kilowatts capable of an average annual output of 172 million kilowatt-hours, and an industrial hydro installation of 36,000 kilowatts with an estimated annual production of 250 million kilowatt-hours. The total existing and definitely scheduled hydroelectric power capacity of Subregion "A" on December 31, 1953 may thus be stated as some 558,000 kilowatts of capacity capable of an average generation of 2,741 million kilowatt-hours per year. The area's largest hydroelectric station is the 72,000-kilowatt Wyman plant of Central Maine Power Company on the Kennebec River.

3. Existing regulatory storage capacity. - A considerable degree of stream flow regulation is provided by the large number of natural lakes and ponds in the subregion, many of which, controlled formerly for log driving, are now operated for power purposes as well. Existing regulatory storage totals about 4,905,000 acre-feet, the two largest reservoirs being Ripogenus (688,700 acre-feet in the Penobscot basin and Moosehead Lake (544,800 acre-feet) in the Kennebec Basin.

4. Undeveloped hydroelectric power. - Detailed discussions of the subregion's undeveloped hydro power potential appear in

Chapters III to X inclusive, each chapter dealing with a single river basin except Chapter X which covers the basins of the several coastal areas. These discussions describe 40 new developments together with 18 redevelopments. The new developments would have a capacity of about 1,177,500 1/ kilowatts capable of generating an average of some 4,515 million kilowatt-hours annually and the redevelopments a capacity of 61,150 kilowatts with average yearly output of 298 million kilowatt-hours. Through the construction of the foregoing projects existing plants would become capable of producing, without redevelopment, an average of about 123 million kilowatt-hours annually, while due to inundation of certain existing installations 13,100 kilowatts of capacity would be lost together with its annual average associated energy of 94 million kilowatt-hours. The net result of the entire scheme of development above outlined would afford an increase of 1,225,550 kilowatts of capacity with an average yearly production of 4,892 2/ million kilowatt-hours. The largest projects are those at Rankin Rapids (230,000 kilowatts) in the Saint John Basin; Pierce Pond (180,000 kilowatts), Cold Stream (90,000 kilowatts) and Indian Pond, now under construction (75,000 kilowatts), in the Kennebec Basin; and the Bangor Diversion (52,000 kilowatts in two plants) in the Penobscot Basin.

5. The distribution of the existing and undeveloped hydroelectric capacity among the various river basins is shown in Table 32. Projects now under construction are classified as "Undeveloped"

1/ Includes Indian Pond, 75,000 kilowatts, and Ripogenus, 36,000 kilowatts, currently under construction.

2/ Including 98,000,000 kilowatt-hours at existing plants not redeveloped.

and the capacity loss through inundation of existing plants has been deducted. Possibilities at the Passamaquoddy Tidal Project are discussed in paragraph 36.

Table 32 - Existing and undeveloped hydroelectric capacity
Subregion "A"

		Installed capacity (kilowatts)		
River basin	Existing	Inventory plan	Possible redevelopment	Total possible undeveloped
Saint John	2,300	255,500	0	255,500
St. Croix	11,152	0	0	0
Penobscot	88,001	309,500	10,925	320,425
Kennebec	134,255	461,000 1/	11,570	472,570
Androscoggin	146,544	92,500	21,080	113,500
Presumpscot	11,244	0	0	0
Saco	44,250	52,400	17,575	69,975
Maine Coastal Area	14,334	4,000	0	4,000
Total	452,080	1,174,900	61,150	1,236,050

1/ Not adjusted for plant replaced at Madison.

6. Undeveloped regulatory storage capacity. - The additional regulatory storage capacity contemplated in connection with the above developments would make available approximately 4,422,000 acre-feet, the two largest reservoirs being those at Rankin Rapids in the Saint John Basin with a usable capacity of 1,460,000 acre-feet and at Stratton Rips in the Penobscot Basin with 863,000 acre-feet. Distribution of existing and undeveloped storage is shown in Table 33.

Table 33 - Existing and undeveloped storage capacity, Subregion "A"

River basin	Usable storage capacity (Acre-Feet) Existing	Undeveloped
Saint John (in Maine)	81,700	2,299,000
St. Croix	592,450	0
Penobscot	1,570,000	1,348,500
Kennebec	1,263,830	317,070
Androscoggin	725,300	182,700
Presumpscot	285,400	0
Saco	92,690	275,000
Maine Coastal Area	293,560	0
Total	4,904,930	4,422,270

7. The preceding paragraphs summarize, and Tables 34, 35 and 36 set forth in more detail, the existing and undeveloped hydroelectric potential of Subregion "A". Following are brief descriptions of the plans for each river basin.

8. Saint John Basin (21,360 sq. mi. total; 7,360 sq. mi. in U.S.). - The two existing hydroelectric plants in the United States portion of the Saint John Basin are on the Aroostook River, have a total capacity of 2,300 kilowatts and serve utility loads. In the Canadian portion of the basin there are three existing utility plants with a capacity of 87,040 kilowatts and two non-utility plants of 2,700 kilowatts capacity. All the Canadian plants are on tributaries except the 57,000-kilowatt Grand Falls utility station on the Saint John River, this being the basin's largest installation.

9. Total usable power storage in the Maine portion of the basin is 81,700 acre-feet, this provided by Squa Pan and Millinocket Lakes in the Aroostook River watershed. In addition several small dams in the basin provide storage for driving pulpwood.

10. The Coordinated Basin Plan for Saint John Basin, set forth in Chapter III, includes the following storage and power projects: (1) Rankin Rapids, (or alternative) storage and power project on the Saint John River; (2) Fish River Falls power development and associated upstream reservoirs on the Fish River; (3) Castle Hill power development and associated upstream reservoir on the Aroostook River. Their installed capacities would total 255,500 kilowatts and average annual output about one billion kilowatt-hours. The projects would provide 2,299,000 acre-feet of usable conservation storage for stream-flow regulation and development of hydroelectric power in Maine and New Brunswick. The largest project, the 230,000-kilowatt development at Rankin Rapids, would provide usable storage of 1,460,000 acre-feet.

11. St. Croix Basin (1,635 sq. mi. total; 1,010 sq. mi. in U.S.). - The two existing hydroelectric plants in the United States portion of the St. Croix Basin, both non-utility stations, are located on the main stem of the river and have a combined capacity of 11,152 kilowatts.

12. Total usable storage in the basin is 592,450 acre-feet, of which 302,000 acre-feet are provided by Grand, North and Spednik

Table 34 - Summary of existing and undeveloped hydroelectric power by river basins, Subregion "A"

River basin	Existing projects: Utility plants No.	Utility plants Installed capacity-kw	Industrial plants 1/ No.	Industrial plants Installed capacity-kw	Total Existing capacity-kw	Undeveloped projects: New plants 2/ No.	New plants Installed capacity-kw 3/	Additions or redevelopments No.	Additions or redevelopments Added capacity-kw	Total undeveloped capacity-kw
Saint John	2	2,300	-	-	2,300	3	255,500	-	-	255,500
St. Croix	-	-	2	11,152	11,152	0	0	-	-	0
Penobscot	11	31,693	7	56,308	88,001	16	309,500 4/	3	10,925	320,425
Kennebec	13	111,700	11	22,555	134,255	8	461,000 5/ 7/	6	11,570	472,570 7/
Androscoggin	10	73,268	21	73,276	146,544	7	92,500	4	21,080	113,580
Presumpscot	3	3,610	6	7,634	11,244	0	-	0	-	0
Saco	11	42,625	3	1,625	44,250	2	52,400 6/	3	17,575	69,975
Maine Coastal	10	12,119	5	2,215	14,334	1	4,000	0	-	4,000
Totals	60	277,315	55	174,765	452,080	37	1,174,900	16	61,150	1,236,050

1/ Existing mechanical hydro power installations are not included.
2/ Does not include 6 storage-only projects - 3 in the Saint John basin; 2 in the Penobscot River basin; one in the Kennebec River basin.
3/ Net after deducting for existing capacity replaced.
4/ Includes the Ripogenus plant with 36,000 kilowatts ultimate installation, (under construction).
5/ Includes Indian Pond project with 75,000 kilowatts ultimate installation, (under construction).
6/ Net after deducting plants inundated.
7/ Not adjusted for 10,470 kilowatts equivalent of hydroelectric and mechanical power replaced at Madison.

Table 35- Pertinent data-Undeveloped hydroelectric power projects- Subregion "A"

River basin and project	River	State	Drainage area sq. miles	Gross static head-feet	Maximum drawdown feet	Usable power storage acre-feet	Installed capacity KW	Energy - 1000 Kwh Average year	Energy - 1000 Kwh Adverse year - 1941	Estimated first costs
Saint John River Basin										
Rankin Rapids	Saint John	Maine	4,060	255	34	1,460,000	230,000	900,000		$65,490,000
Fish River Lake	Fish	Maine	131	Storage only	29	124,000	-	-		2,120,000
St. Froid Lake	Fish	Maine	279	Storage only	28.5	115,000	-	-		2,605,000
Fish River Falls	Fish	Maine	863	45	5	65,000	7,500	31,700		3,110,000
Masardis	Aroostook	Maine	601	Storage only	90	535,000	-	700		8,120,000
Castle Hill	Aroostook	Maine	1,531	60		Pondage	18,000	70,700		5,885,000
Total						2,299,000	255,500	1,002,400	921,600	$87,330,000
Penobscot River Basin										
Ripogenus (under construction)	West Branch	Maine	1,410	186	44	688,700 1/	36,000	250,000		
The Arches	West Branch	Maine	1,415	90	-	Pondage	22,500	94,250		$ 10,092,000
Sourdnahunk	West Branch	Maine	1,435	95	-	Pondage	24,000	109,450		11,386,000
Debsconeag	West Branch	Maine	1,545	58	-	Pondage	15,000	69,000		8,774,000
Allagash Lake	East Branch	Maine	79	Storage only	7.5	32,500	-	-		547,000
Grand Pitch	East Branch	Maine	280	90	-	Pondage	5,000	22,270		2,878,000
Grand Lake	East Branch	Maine	548	140	22	181,900 2/	15,000	58,930		12,849,000
Grand Falls	East Branch	Maine	686	50	-	Pondage	6,000	28,100		2,989,000
Whetstone Falls	East Branch	Maine	985	135	25	255,000	30,000	116,700		28,739,000
Meadow Brook	East Branch	Maine	1,070	50	-	Pondage	12,000	48,600		7,589,000
Stratton Rips	Mattawamkeag	Maine	1,484	140	28	863,000	40,000	170,060		44,222,000
Bonnie Brook	Piscataquis	Maine	1,254	91	24	57,400	20,000	76,500		13,611,000
Winn (Five Islands)	Penobscot	Maine	4,870	23	-	Pondage	12,000	89,170		8,701,000
Mohawk Rapids	Penobscot	Maine	5,131	16	-	Pondage	8,000	61,620		9,711,000
Bangor Diversion										52,259,000
Sunkhaze	Penobscot	Maine	7,268	28	-	Pondage	12,000	94,600		
Diversion	Penobscot	Maine	7,553	115	-	Pondage	40,000	223,000		
Basin Mills	Penobscot	Maine	7,686	27	-	Pondage	12,000	93,150		6,888,000
Sub-total						2,078,500	309,500	1,605,400	1,435,600	$221,175,000
Less existing storage at Grand Lake and Ripogenus						- 730,000				
Redevelopments (3 plants)							10,925	62,700 7/	55,800	
Total						1,348,500	320,425	1,668,100	1,491,400	

Table 35 (Continued)

River basin and project	River	State	Drainage area sq. miles	Gross static head-feet	Maximum drawdown feet	Usable power storage acre-feet	Installed capacity kw	Energy - 1000 Kwh Average year	Energy - 1000 Kwh Adverse year - 1941	Estimated first costs
Kennebec River Basin										
Moosehead	Kennebec	Maine	1,242	64	7.5	544,800	24,000	66,700		$ 10,093,000
Indian Pond (under Const.)	Kennebec	Maine	1,355	150	-	Pondage	75,000	172,000		16,616,000
Cold Stream	Kennebec	Maine	1,416	195	-	Pondage	90,000	259,350		29,799,000
The Forks (Low Dam)	Kennebec	Maine	2,460 3/ 4/	110	-	Pondage	48,000	166,300		28,180,000
Grand Falls	Dead	Maine	769	Storage only	47	226,900 5/	-	-		11,902,000
Pierce Pond	Pierce Stream	Maine	788	690	3.5	10,000	180,000	459,000		49,102,000
North Anson	Kennebec	Maine	2,797	29	-	Pondage	10,000	54,250		6,405,000
Madison	Kennebec	Maine	3,230	64	-	Pondage	24,000	146,780		7,772,000
Greenleaf	Sandy	Maine	513	120	35.0	100,000	10,000	41,600		11,329,000
Sub-total						881,700	461,000	1,365,980	1,188,500	$171,198,000
Less existing storage at Moosehead and Grand Falls						- 564,630				
Redevelopments (6 plants)							11,570	60,000 8/	53,000	
Added energy at existing plants (without redevelopments)						-	-	10,120	8,800	
Total						317,070	472,570 6/	1,436,100 6/	1,250,300	
Androscoggin River Basin										
Aziscohos	Magalloway	Maine	214	245	26.0	159,300	10,000	49,080		$ 3,558,000
Errol	Androscoggin	N.H.	1,045	55	16.0	314,000	24,000	56,800		14,687,000
Mollidgewock	Androscoggin	N.H.	1,152	45	-	Pondage	22,500	53,550		8,840,000
Pontook	Androscoggin	N.H.	1,214	80	-	Pondage	12,000	88,410		6,457,000
Pulsifer Rips	Androscoggin	N.H.	1,363	40	-	Pondage	6,000	42,640		3,555,000
Gilead	Androscoggin	Maine	1,592	40	-	Pondage	8,000	56,570		8,818,000
Dixfield	Androscoggin	Maine	2,205	25	-	Pondage	10,000	49,310		7,061,000
Sub-total						473,300	92,500	396,360	348,200	$ 52,976,000
Less existing storage at Aziscohos and Errol						- 290,600				
Redevelopments (4 plants)							21,000	119,630 9/	105,000	
Added energy at existing plants								64,960	57,000	
Total						182,700	113,500	580,950	510,200	

Table 35 (Continued)

River basin and project	River	State	Drainage area sq. miles	Gross static head-feet	Maximum drawdown feet	Usable power storage acre-feet	Installed capacity kw	Energy - 1000 Kwh Average year	Energy - 1000 Kwh Adverse year - 1941	Estimated first costs
Saco River Basin										
Great Falls	Saco	Maine	828	111	28.0	275,000	40,000	87,210		$ 26,866,000
Steep Falls	Saco	Maine	1,340	38	-	Pondage	15,000	47,690		7,248,000
Sub-total						275,000	55,000	134,900	98,050	$ 34,114,000
Redevelopments (3 plants)							17,575	55,780	40,300	
Added energy at existing plants								22,770 10/	16,550	
Less plants inundated							- 2,600	19,000	- 13,700	
Total						275,000	69,975	194,450	141,200	
Maine Coastal Areas										
Ellsworth Falls	Union	Maine	503	22		-	4,000	10,200		$ 2,449,000
Sub-total							4,000	10,200	28,340	$ 2,449,000
Total							4,000	10,200	28,340	
Grand Total - Subregion "A" (Not including Passamaquoddy Tidal Power Project)						4,422,270	1,235,970 6/	4,892,200	4,343,040	$569,242,000

1/ Existing.
2/ Includes 41,300 acre-feet existing storage.
3/ Includes 769 sq. miles at Grand Falls.
4/ Plant utilizes flow 1,691 sq. miles.
5/ Includes 19,830 acre-feet presently usable at Spencer Lake and Dead River Pond.
6/ Not adjusted for 10,470 kilowatts equivalent of hydroelectric and mechanical power replaced at Madison.
7/ Increase would be 6,450,000 kwh without redevelopment.
8/ Increase would be 11,640,000 kwh without redevelopment.
9/ Increase would be 690,000 kwh without redevelopment.
10/ Increase at five existing plants would be 29,580,000 kwh without redevelopment.

Table 36 - Physical data-Existing utility and non-utility storage and power projects, Subregion "A"

River basin and project	River	Drainage area (sq.miles)	Gross static head (feet)	Maximum drawdown (feet)	Usable storage (acre-feet)	Installed capacity (kw)	Average annual generation (1000 kwh)	Owner or operator
Saint John River Basin								
Utility								
Squa Pan	Squa Pan Lake	66	30	-	59,000	1,500	800	Maine Public Service Co.
Caribou	Aroostook	1,930	12	-	-	800	4,500	Maine Public Service Co.
Sub-total					59,000	2,300	5,300	
Non-utility (none)								
Other usable storage					22,700			
Total for basin					81,700	2,300	5,300	
St. Croix River Basin								
Utility (none)								
Non-utility								
Woodland	St. Croix	1,350	48	-	-	1,500	7,500	St. Croix Paper Co.
Grand Falls	St. Croix	1,320	52	8	87,000	9,652	48,000	
Sub-total - non utility plants					87,000	11,152	55,500	
Other usable storage					505,450			
Total for basin					592,450	11,152	55,500	

Table 36 - (Continued)

River basin and project	River	Drainage area (sq. miles)	Gross static head (feet)	Maximum drawdown (feet)	Usable storage (acre-feet)	Installed capacity (kw)	Average annual generation (1000 kwh)	Owner or operator
Penobscot River Basin								
Utility								
Veazie	Penobscot	7,800	17	-	-	8,400	50,000	Bangor Hydro-Electric Co.
Orono	Stillwater	7,710	25	-	-	2,332	15,000	Bangor Hydro-Electric Co.
Stillwater	Stillwater	7,600	20	-	-	1,950	7,500	Bangor Hydro-Electric Co.
Milford	Penobscot	7,600	18	-	-	7,800	45,000	Bangor Hydro-Electric Co.
Howland	Piscataquis	1,500	16	-	-	1,875	10,900	Bangor Hydro-Electric Co.
Stanford	Penobscot	5,100	20	-	-	3,800	28,900	Bangor Hydro-Electric Co.
Medway	Penobscot	2,120	18	-	-	3,440	30,879	Bangor Hydro-Electric Co.
East Orland	Toddy	25	125	-	-	500	1,900	Central Maine Power Co.
Bangor	Penobscot	8,000	10	-	-	700	3,700	City of Bangor
Milo	Sebec	407	11	-	-	320	1,500	Bangor Hydro-Electric Co.
Greenville	Wilson Stream	40	85	-	-	576	1,000	Central Maine Power Co.
Sub-total - Utility plants						31,693	196,279	
Non-utility								
Great Works	Penobscot	7,680	17	-	-	5,554	31,000	Penobscot Chemical Fibre Co
Dover Foxcroft	Piscataquis	352	22	-	-	854	680	American Woolen Co.
Mattaseunk	Penobscot	3,308	40	2		19,200	106,900	Great Northern Paper Co.
Dolby	West Branch	2,080	49	2	-	14,100	86,200	Great Northern Paper Co.
East Millinocket	West Branch	2,000	25	-	-	1/	-	
Millinocket	West Branch	1,880	110	1	-	8,000	32,400	Great Northern Paper Co.
North Twin	West Branch	1,864	29	15	344,300	8,200	44,500	Great Northern Paper Co.
Old Town	Penobscot	7,600	20	-	-	400	3,000	Old Town Woolen Co.
Sub-total - Non-utility plants					344,300	56,308	304,680	
Other usable storage					1,225,700			
Total for basin					1,570,000	88,001	500,959	

1/ 9,890 horsepower (mechanical).

Table 36 (Continued)

River basin and project	River	Drainage area (sq. miles)	Gross static head (feet)	Maximum drawdown (feet)	Usable storage (acre-feet)	Installed capacity (kw)	Average annual generation (1000 kwh)	Owner or operator
Kennebec River Basin								
Utility								
Fort Halifax	Sebasticook	975	22	-	-	1,500	6,400	Central Maine Power Co.
Burnham	Sebasticook	598	27	-	-	1,050	3,000	Central Maine Power Co.
Messalonskee No. 5	Messalonskee	200	35	-	-	1,500	3,900	Central Maine Power Co.
Messalonskee No. 3	Messalonskee	185	42	-	-	1,600	4,300	Central Maine Power Co.
Messalonskee No. 2	Messalonskee	175	66	-	-	2,800	8,000	Central Maine Power Co.
Shawmut	Kennebec	4,200	22	-	-	4,650	34,000	Central Maine Power Co.
Weston	Kennebec	3,950	32	6	-	12,000	66,000	Central Maine Power Co.
Williams	Kennebec	2,700	42	8	-	13,000	60,000	Central Maine Power Co.
Wyman	Kennebec	2,600	138	23	60,380	72,000	275,000	Central Maine Power Co.
Messalonskee No. 4	Messalonskee	200	23	-	-	800	2,300	Central Maine Power Co.
Norridgewock	Sandy	619	15	-	-	450	1,300	Madison Electric Works
Eustis	No. Branch Dead	165	12	-	-	250	-	Stratton Light Co.
Dennistown	Crocker	33	215	-	-	100	200	Central Maine Power Co.
Sub-total - Utility plants					60,380	111,700	464,300	
Non-Utility								
Copsecook	Cobbosse	240	37	-	-	300	860	S.D. Warren Co.
Winthrop	Maranacook	33	23	-	-	100	340	Winthrop Mills
Augusta	Kennebec	5,550	22	-	-	375	2,500	Hudson Pulp & Paper Co.
Edwards	Kennebec	5,470	22	-	-	2,550	8,500	Bates Manufacturing Co.
No. Vassalboro	China Lake		30	-	-	280	310	American Woolen Co.
Pioneer	Sebasticook	320	10	-	-	250	660	American Woolen Co.
Waterville	Kennebec	4,270	21	-	-	7,200	24,000	Lockwood Co.
T. A. Mills	Kennebec	4,270	23	-	-	3,730	25,500	Hollingsworth & Whitney
Abenagus	Kennebec	3,230	42	-	-	1,650 2/	5,400	Hollingsworth & Whitney
Wilton	Wilton	-	30	-	-	120	120	Wilton Woolen Co.
Anson(Madison)	Kennebec	3,230	22	-	-	6,000	51,500	Great Northern Paper Co.
Sub-total - Non-utility plants					-	22,555	119,690	
Other usable storage					1,203,450			
Total for basin					1,263,830	134,255	583,990	

2/ Total installation 10,740 kilowatts of equivalent power (hydroelectric and mechanical).

Table 36 - (Continued)

River basin and project	River	Drainage area (sq. miles)	Gross static head (feet)	Maximum drawdown (feet)	Usable storage (acre-feet)	Installed capacity (kw)	Average annual generation (1000 kwh)	Owner or operator
Androscoggin River Basin								
Utility								
Brunswick	Androscoggin	3,470	19	-	-	1,473	11,300	Central Maine Power Co.
Deer Rips	Androscoggin	2,900	31	4	760	6,540	26,000	Central Maine Power Co.
Androscoggin No. 3	Androscoggin	2,900	32	-	1,000	3,600	20,000	Central Maine Power Co.
Gulf Island	Androscoggin	2,860	55	4	5,050	19,200	100,000	Central Maine Power Co.
Upper	Androscoggin	2,073	99	2	720	24,000	145,000	Rumford Falls Power Co.
Gorham	Androscoggin (N.H.)	1,431	18	-	64	2,150	15,300	Public Service Co. of New Hampshire
Smith	Androscoggin (N.H.)	1,365	87	-	-	15,000	105,800	Public Service Co. of New Hampshire
Norway	Pennesseewassee	23	52	-	-	280	200	Central Maine Power Co.
Lewiston	Androscoggin	2,900	25	-	-	700	3,000	Lewiston Public Works
Kennebago	Kennebago	112	32	-	-	325	800	Oquossoc Light and Power Co.
Sub-total - Utility plants					7,594	73,268	427,400	
Non-utility								
Brunswick	Androscoggin	3,430	14	-	-	2,430	9,200	Verney Corporation
Pejepscot	Androscoggin	3,430	22	-	-	1,100	4,000	Pejepscot Paper Co.
Worumbo	Androscoggin	3,370	19	-	-	900	3,300	Worumbo Manufacturing Co.
Lewiston	Androscoggin	2,990	35	-	-	100	230	Pepperell Manufacturing Co.
Lewiston	Androscoggin	2,990	28	-	-	800	2,700	W. S. Libbey Co.
Lewiston	Androscoggin	2,990	22	4	1,000	1,776	8,600	Continental Mills
Lewiston	Androscoggin	2,990	28	-	-	5,960	16,700	Bates Manufacturing Co.
Lewiston	Androscoggin	2,990	25	-	-	2,160	9,500	Bates Manufacturing Co.
Lewiston	Androscoggin	2,990	25	-	-	2,240	7,800	Bates Manufacturing Co.
Livermore Falls	Androscoggin	2,550	31	2	80	3,360	22,000	International Paper Co.
Otis	Androscoggin	2,540	24	2	200	2,680	10,000	International Paper Co.
Jay	Androscoggin	2,535	14	2	390	3,000	16,000	International Paper Co.
Island	Androscoggin	2,080	80	-	21	12,800	40,000	Oxford Paper Co.
Oxford	Thompson Stream	-	11	-	-	120	160	Robinson Manufacturing Co.
Mechanic Falls	Little Androscoggin	200	36	-	-	1,310	2,400	A & P Corrugated Box Co.

Table 36 - (Continued)

River basin and project	River	Drainage area (sq. miles)	Gross static head (feet)	Maximum drawdown (feet)	Usable storage (acre-feet)	Installed capacity (kw)	Average annual generation (1000 kwh.)	Owner or operator
Shelburne	Androscoggin (N.H.)	1,500	17	-	-	3,720	14,000	Brown Co.
Gorham	Androscoggin (N.H.)	1,400	30	-	-	4,800	26,000	Brown Co.
Cascade	Androscoggin (N.H.)	1,350	45	-	-	7,200	48,000	Brown Co.
Cross Power	Androscoggin (N.H.)	1,350	23	-	-	3,220	19,000	Brown Co.
Riverside	Androscoggin (N.H.)	1,350	65	-	-	11,400	74,000	Brown Co.
Berlin	Androscoggin (N.H.)	1,350	16	-	-	2,200	14,000	Brown Co.
Sub-total - Non-utility plants					1,691	73,276	347,590	
Other usable storage					716,315			
Total for Androscoggin River Basin					725,600	146,544	774,990	

Table 36 - (Continued)

River basin and project	River	Drainage area (sq. miles)	Gross static head (feet)	Maximum drawdown (feet)	Usable storage (acre-feet)	Installed capacity (kw)	Average annual generation (1000 kwh)	Owner or operator
Presumpscot River Basin								
Utility								
Mallison	Presumpscot	501	19	-	-	1,000	5,600	Central Maine Power Co.
No. Groham	Presumpscot	438	34	-	-	2,250	11,700	Central Maine Power Co.
Bridgton	Willett	54	50	-	-	360	400	Central Maine Power Co.
Sub-total - Utility plants						3,610	17,700	
Non-utility								
Smelt Hill	Presumpscot	635	14	-	-	900	4,040	S. D. Warren Co.
Cumberland	Presumpscot	570	22	-	-	600	632	S. D. Warren Co.
Saccarappa	Presumpscot	569	28	-	-	1,350	10,580	S. D. Warren Co.
Dundes	Presumpscot	443	51	8	1,460	2,400	16,200	S. D. Warren Co.
Eel Weir	Presumpscot	436	40	-	-	1,800	11,650	S. D. Warren Co.
Newhall	Presumpscot	496	24	-	-	584	1,900	E. I. Dupont de Nemours Co.
Sub-total - Non-utility plants					1,460	7,634	45,002	
Other usable storage					283,940			
Total for basin					285,400	11,244	62,702	

Table 36 -(Continued)

River basin and project	River	Drainage area (sq. miles)	Gross static head (feet)	Maximum drawdown (feet)	Usable storage (acre-feet)	Installed capacity (kw)	Average annual generation (1000kwh)	Owner of operator
Saco River Basin								
Utility								
Cataract	Saco	1,700	44	4	-	6,650	30,000	Central Maine Power Co.
Skelton	Saco	1,623	74	6	-	16,800	75,000	Central Maine Power Co.
Bar Mills	Saco	1,590	19	-	-	1,600	6,000	Central Maine Power Co.
West Buxton No. 1	Saco	1,550	27	-	-	4,000)	24,000	Central Maine Power Co.
West Buxton No. 2	Saco	1,550	27	-	-	2,625)		
Bonny Eagle	Saco	1,540	38	6	-	7,200	31,000	Central Maine Power Co.
Hiram	Saco	828	75	-	-	2,400	19,000	Central Maine Power Co.
Kezar Falls	Ossipec	420	16	-	-	350	1,400	Cornish and Kezar Falls Light and Power Co.
Fryburg	Saco	516	13	-	-	640	1,600	Swans Falls Co.
Goodrich Falls	Ellis River	53	72	-	-	250	1,500	White Mountain Power Co.
Goodwin Mill	Pond Brook	-	27	-	-	110	-	White Mountain Power Co.
Sub-total - Utility plants						42,625	189,500	
Non-utility								
York	Saco	1,680	20	-	-	1,115	4,700	Bates Manufacturing Co.
Lovell	Kezar River	-	16	-	-	140	-	Bates Manufacturing Co.
Kezar Falls	Ossippee River	420	13	-	-	370	-	
Sub-total - Non-utility plants						1,625	4,700	
Other usable storage					92,690			
Total for basin					92,690	44,250	194,200	

Table 36 - (Continued)

River basin and project	River	Drainage area (sq. miles)	Gross static head (feet)	Maximum drawdown (feet)	Usable storage (acre-feet)	Installed capacity (kw	Average annual generation (1000 kwh)	Owner or operator
Maine Coastal Areas								
Utility								
Kennebunk	Mousam	-	-	-	-	150	600	Kennebunk Electric Light Dept.
West Kennebunk	Mousam	115	18	-	-	208	400	Kennebunk Electric Light Dept.
Whiting	Orange	-	-	-	-	96	600	Lubec Water and Electric Dept.
East Machias	East Machias	300	30	-	-	1,320	3,600	Bangor Hydro-Electric Co.
Machias	Machias	474	25	-	-	350	1,700	Bangor Hydro-Electric Co.
Little Falls, Pembroke	Pennamaquan	-	18	-	-	120	-	Bangor Hydro-Electric Co.
Iron Works, Pembroke	Pennamaquan	-	30	-	-	150	-	Bangor Hydro-Electric Co.
Belfast	Goose	-	103	-	-	425	600	Central Maine Power Co.
Damariscotta Mills	Damariscotta	57	66	-	-	400	1,500	Central Maine Power Co.
Ellsworth	Union	542	60	-	-	8,900	24,000	Bangor Hydro-Electric Co.
Sub-total - Utility plants						12,119	33,000	
Non-utility								
Old Falls	Mousam	110	62	-	-	1,000	370	York Utilities Co.
Estes	Mousam	36	36	-	-	500	780	York Utilities Co.
Sanford	Mousam	40	17	-		200	140	Goodall Sanford, Inc.
Camden	Megunticook	30	-	-	-	240	380	Seabright Woven Felt Co.
Belfast	Goose	-	-	-	-	275	-	Daly Brothers Shoe Co.
Sub-total - Non-utility plants					-	2,215	1,670	
Other usable storage					293,560			
Total for basin					293,560	14,334	34,670	
Total utility plants in Subregion "A"					-	277,315	1,333,479	
Total non-utility plants in Subregion "A"					-	174,765	878,832	
Grand total - Subregion "A" 3/					4,904,930	452,080 3/	2,212,311	

3/ In addition, there are 13 plants with 2,370 horsepower (mechanical).

international Lakes. This available storage is used for power and log-driving purposes.

13. The Coordinated Plan for the St. Croix Basin set forth in Chapter IV, does not include any storage and power projects. None of the 13 projects investigated in detail met the economic criteria adopted for the inventory of undeveloped water power.

14. Penobscot Basin (8,570 sq. mi.) - There are 11 existing hydroelectric utility plants in the Penobscot Basin with a capacity of 31,693 kilowatts and eight 3/ non-utility Stations of 56,308 kilowatts capacity. This total of nearly 88,000 kilowatts is divided about equally between installations on the main river and those on tributaries.

15. The largest plants, both industrial, are Mattaseunk (19,200 kilowatts) on the Penobscot River and Dolby (14,100 kilowatts) on the West Branch. In addition to the foregoing there is under construction an industrial power plant of 36,000 kilowatts ultimate capacity at the existing Ripogenus Dam on the West Branch.

16. Existing usable storage capacity totals about 1,570,000 acre-feet including nearly 1,300,000 acre-feet on the West Branch, 689,000 acre-feet of the latter at the Ripogenus project. All of this storage is operated for power and log-driving purposes.

17. The Coordinated Plan for the Penobscot Basin, set forth in Chapter V includes four storage and power projects, 10 power-only projects, and one storage-only

3/ One plant with 9,890 horsepower (mechanical).

project. The 15 projects and their capacities are distributed among the subbasins as follows: (1) West Branch, three projects, 61,500 kilowatts; (2) East Branch, six projects, 68,000 kilowatts; (3) Mattawamkeag River, one project, 40,000 kilowatts; (4) Piscataquis River, one project, 20,000 kilowatts; (5) main Penobscot River, four projects, 84,000 kilowatts.

18. These projects plus Ripogenus currently under construction would increase the basin's available storage by 1,348,500 acre-feet, provide 309,500 4/ kilowatts of additional capacity and produce 1,605 5/ million kilowatt-hours annually. The plan would afford a potential increase of 10,925 kilowatts in installed capacity at existing plants and generation there of an additional 62,700 thousand kilowatt-hours annually. The largest projects in the plan are the Bangor Diversion on the main river with 52,000 kilowatts installed in two plants; the 40,000-kilowatt Stratton Rips project on the Mattawamkeag River and the 30,000-kilowatt Whetstone Falls project on the East Branch of the Penobscot. The Stratton Rips project would provide the greatest usable storage capacity (863,000 acre-feet).

19. Kennebec Basin (5,870 sq. mi.). - There are 13 existing hydroelectric utility plants in the Kennebec Basin with a capacity of 111,700 kilowatts and 11 non-utility stations with 22,555 kilowatts installed. The three largest utility plants are Wyman (72,000 kilowatts), Williams (13,000 kilowatts), and Weston (12,000 kilowatts), all on the main river. The largest industrial hydroelectric plant is the Anson plant.

4/ 36,000 kw. currently being installed at Ripogenus Project
5/ 250,000,000 kwh from Ripogenus Project.

at Madison (6,000 kilowatts), also on the main river. A number of small industrial plants of hydro-mechanical type are scattered throughout the basin.

20. In addition to the foregoing the 75,000-kilowatt hydro project at Indian Pond, on the main river, is now under construction by the Central Maine Power Company and will provide 18,400 acre-feet of pondage for daily and weekly regulation.

21. Existing reservoirs in the basin provide 1,263,830 acre-feet of storage capacity for river regulation 544,800 acre-feet of this in Moosehead Lake. Flagstaff Lake, above Long Falls on the Dead River is the most recent storage addition. This was completed in 1950 and has a capacity of 275,500 acre-feet. Much of the storage in the basin, originally designed solely for log-driving, is now used also for power.

22. The Coordinated Plan for the Kennebec River basin, set forth in Chapter VI, includes (1) four power projects on the Upper Kennebec, (2) a storage dam on the Dead River and diversion of water from this and existing storage on the Dead River to Pierce Pond (3) a dam at Pierce Pond with a 180,000-kilowatt powerhouse on the Kennebec River to utilize the fall between the pond and the river, (4) three power projects on the lower Kennebec.

23. These projects would increase the available storage for stream flow regulation by 317,070 acre-feet, would have an installed capacity of 461,000 kilowatts, and would produce an average

·55

annual output of 1,388 million kilowatt-hours. The storage provided in the plan would permit the installation of an additional 11,570 kilowatts at six existing plants and increase the average annual output of all existing plants by about 70 million kilowatt-hours. The largest power plant and greatest amount of new storage would be in the Pierce Pond Diversion project.

24. Androscoggin Basin (3,450 sq. mi.). - There are 10 existing hydroelectric utility plants in the Androscoggin basin with a capacity of 73,268 kilowatts and 21 non-utility stations with 73,276 kilowatts installed. The largest existing plants are the utility stations at Upper Rumford Falls (24,000 kilowatts) and at Gulf Island (19,200 kilowatts).

25. Existing storage in the basin totals 725,600 acre-feet, 660,000 acre-feet of this in the upper watershed above Berlin, New Hampshire. The largest storages are in Aziscohos Lake (220,000 acre-feet) and Mooselookmeguntic Lake (190,000 acre-feet). The purposes served by the storage, in addition to power, include water supply and log driving.

26. The Coordinated Plan for the Androscoggin basin, set forth in Chapter VII, includes (1) five power projects at sites now undeveloped, (2) installation of power facilities at an existing storage dam (3) a combined power and storage project at the site of an existing storage development. These seven projects

would be located in the headwaters section of the basin, six of them on the main river.

27. The projects would increase the available storage for stream regulation by 182,700 acre-feet, installed capacity by 92,500 kilowatts and produce an additional 396 million kilowatt-hours annually. The plan would also permit the installation of an additional 21,080 kilowatts in installed capacity at four locations where redevelopments are considered feasible, and an additional annual generation of about 120 million kilowatt-hours. Energy output at existing plants not redeveloped would be increased by about 65 million kilowatt-hours. The largest potential plants are Errol (24,000 kilowatts) and Mollidgewock (22,500 kilowatts). The Errol project would also provide the greatest increase in storage capacity.

28. Presumpscot Basin (648 sq. mi.) - There are three existing utility hydroelectric plants in the Presumpscot basin with a capacity of about 3,600 kilowatts and six industrial plants with an aggregate installation of about 7,634 kilowatts in electric generating capacity and 2,000 horsepower of mechanical drive. In addition there are numerous small industrial plants in the basin with mechanical drive installations of 100 horsepower or less which altogether have a total capacity of about 1,600 horsepower. The combined usable storage capacity totals 285,400 acre-feet, of which 222,600 acre-feet are in Sebago Lake, the major source of

5

water supply for Portland. The remaining 62,300 acre-feet are in lakes and ponds which are operated for industrial purposes.

29. Studies indicate that in the Presumpscot River basin no new power or storage developments appear feasible at present. Therefore the Coordinated Plan for the Presumpscot River basin, set forth in Chapter VIII includes no new power or storage developments.

30. Saco Basin (1,697 sq. mi.) - there are eleven existing utility hydroelectric plants in the Saco basin with a capacity of 42,625 kilowatts and three industrial plants with 1,625 kilowatts installed, most of the existing capacity being located on the main river. The Skelton plant (16,800 kilowatts) is the basin's largest plant.

31. Storage capacity totals 92,690 acre-feet in 12 small reservoirs, all utilized for power.

32. The Coordinated Plan for the Saco River Basin, set forth in Chapter IX, includes a combined storage and power project (Great Falls) and a power-only project (Steep Falls), both on the main river. The two projects would increase storage capacity by 275,000 acre-feet, provide 52,400 kilowatts of additional capacity and produce an additional 116 million kilowatt-hours annually. The capacity of the Great Falls plant would be 40,000 kilowatts. The additional storage provided by the plan would also make possible redevelopment of three existing plants, a further increase of

17,575 kilowatts in installed capacity and the annual production of an additional 79 million kilowatt-hours.

33. Maine Coastal Area (5,999 sq. mi.). - There are ten existing hydroelectric utility plants in the Maine Coastal Area basins with a capacity of 12,119 kilowatts and five industrial plants with 2,215 kilowatts installed. The Ellsworth utility station (8,900 kilowatts) on the Union River is the basins' largest plant.

34. The total usable storage capacity is about 293,560 acre-feet, the largest storage (149,200 acre-feet) being in Graham Lake in the Union River basin.

35. The Coordinated Plan for the Maine Coastal Area set forth in, Chapter X, includes the Ellsworth Falls power project on the Union River, with 4,000 kilowatts of capacity capable of producing an average annual output of about 10 million kilowatt-hours.

36. Passamaquoddy tidal project - The development of tidal power at Passamaquoddy has been the subject of study for some 30 years. Tidal power, when economically feasible of development, possesses certain distinct advantages over other power sources. The supply of water is unaffected by floods, droughts, or ice-jams, is thoroughly dependable and is predictable with accuracy. With the so-called two-pool plan under the international development, a continuous supply of power could be produced. Since the output would not be constant but would fluctuate in accordance with the

tides it would be necessary to firm up the tidal power with power from auxiliary sources. Such sources could include the potential hydroelectric projects in the river basin of Subregion "A". A comprehensive survey, estimated to cost $3,000,000, would be required to determine the economic feasibility of developing power at Passamaquoddy.

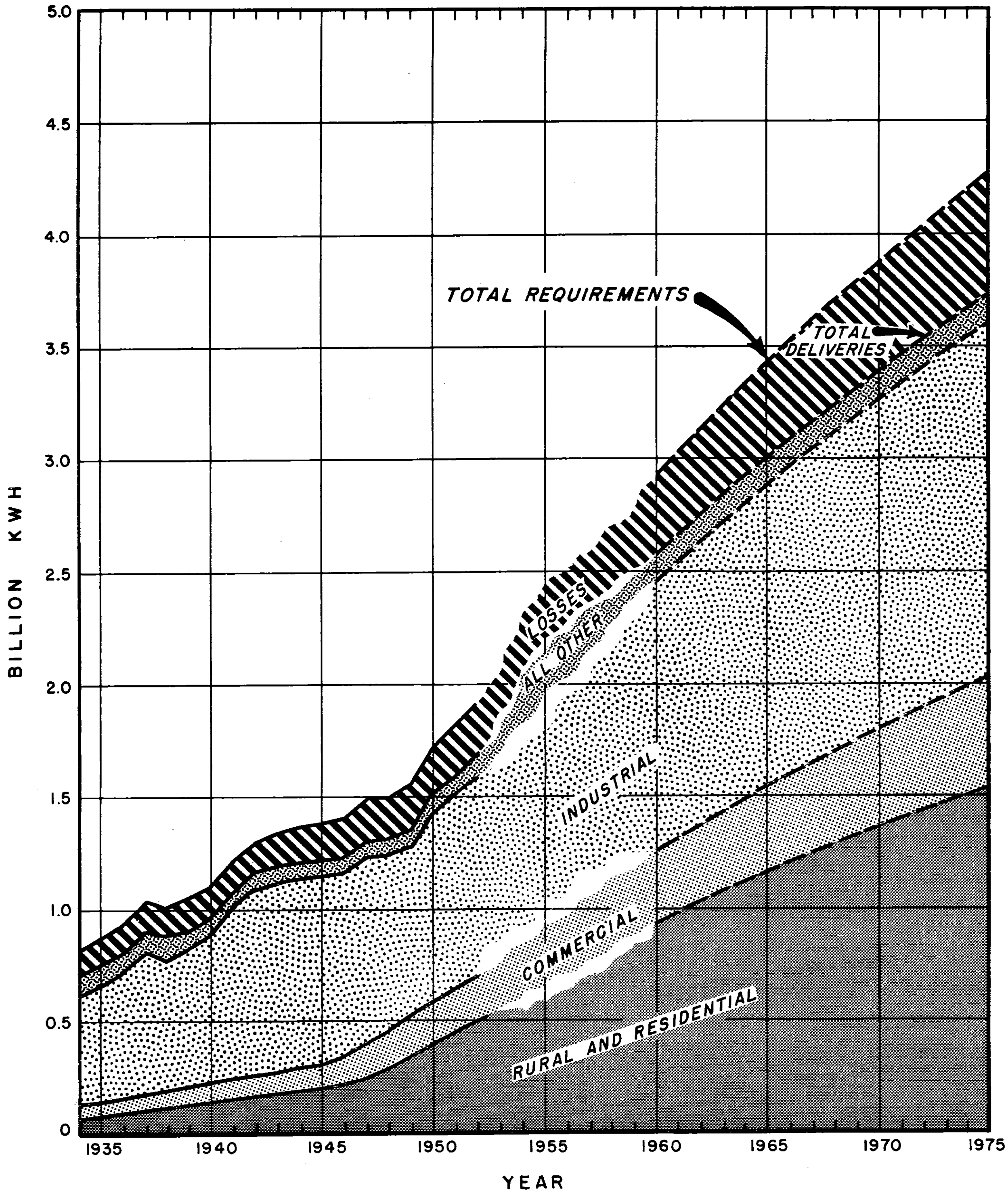
POWER SUPPLY - POWER REQUIREMENTS - POWER UTILIZATION

37. General. - A brief discussion of the subregion's power supply, estimated future requirements and possible utilization of its undeveloped water power and power values, is set forth in the following paragraphs. For a more detailed treatment of these subjects see Chapter XI - Special Subjects Subregion "A".

38. Future power requirements. - An essential part of a study with respect to undeveloped power resources is the estimate of future requirements of the area under consideration. Analysis of the subregion's past power requirements and the conditions which may reasonably be expected to prevail in the foreseeable future, in the present instance to the year 1975, will indicate the power market probable in coming years. Taking into account the estimated increae in population, continued expansion of applications of electric energy in all classes of service, combined with consideration of past trends, it is estimated that the annual electric utility energy requirements of Maine, which coincides to a controlling extent with Subregion "A", will grow from the 1,942 million kilowatt-

Table 37 - Power requirements of all electric utilities
Power supply area 1, 1934-1975, Subregion "A"

Year	Energy deliveries to ultimate consumers - 1,000 kwh: Rural and residential	Commercial	Industrial	All others	Total	Losses 1000 kwh	Total energy requirements 1000 kwh	Load factor percent	Non-coincident peak demand 1000 kw
1934	77,424	56,901	489,138	84,082	707,454	109,458	817,003	54.5	171
1935	83,731	60,663	526,545	90,078	761,017	119,659	880,676	55.9	180
1936	95,152	65,975	572,125	80,495	813,747	126,511	940,258	55.9	191
1937	106,872	69,089	645,562	92,528	914,051	128,991	1,043,042	63.6	187
1938	120,071	75,628	591,249	96,311	883,259	126,942	1,010,201	59.3	194
1939	130,697	83,623	621,003	79,540	914,863	133,054	1,047,917	59.0	203
1940	143,620	91,471	670,558	66,514	972,163	136,163	1,108,326	60.3	209
1941	152,410	98,141	782,291	57,613	1,090,455	145,670	1,236,125	61.7	229
1942	161,903	96,691	843,163	64,529	1,166,286	143,798	1,310,084	65.0	230
1943	173,884	95,325	864,375	68,581	1,204,165	143,141	1,349,306	65.5	235
1944	188,409	101,076	854,930	73,789	1,218,204	148,865	1,367,069	63.6	245
1945	203,757	109,118	837,512	72,489	1,222,876	163,577	1,386,453	63.0	251
1946	226,459	126,876	814,670	62,866	1,230,871	173,329	1,404,200	60.9	263
1947	254,408	143,655	839,703	69,115	1,306,881	180,312	1,487,193	60.9	279
1948	294,625	158,866	798,549	68,341	1,320,381	182,927	1,503,308	59.0	290
1949	358,221	169,333	766,051	69,597	1,363,202	201,377	1,564,579	59.1	302
1950	405,320	183,276	863,253	70,618	1,522,467	215,481	1,737,948	60.9	326
1951	459,104	193,948	885,806	74,836	1,612,694	223,993	1,836,687	59.5	352
1952	499,788	201,261	903,545	96,814	1,701,408	240,838	1,942,246	57.6	385
1960 Est.	945,000	315,000	1,200,000	110,000	2,570,000	360,000	2,930,000	58.5	575
1975 Est.	1,550,000	500,006	1,560,000	130,000	3,740,000	540,000	4,280,000	61.2	800



SUBREGION "A"

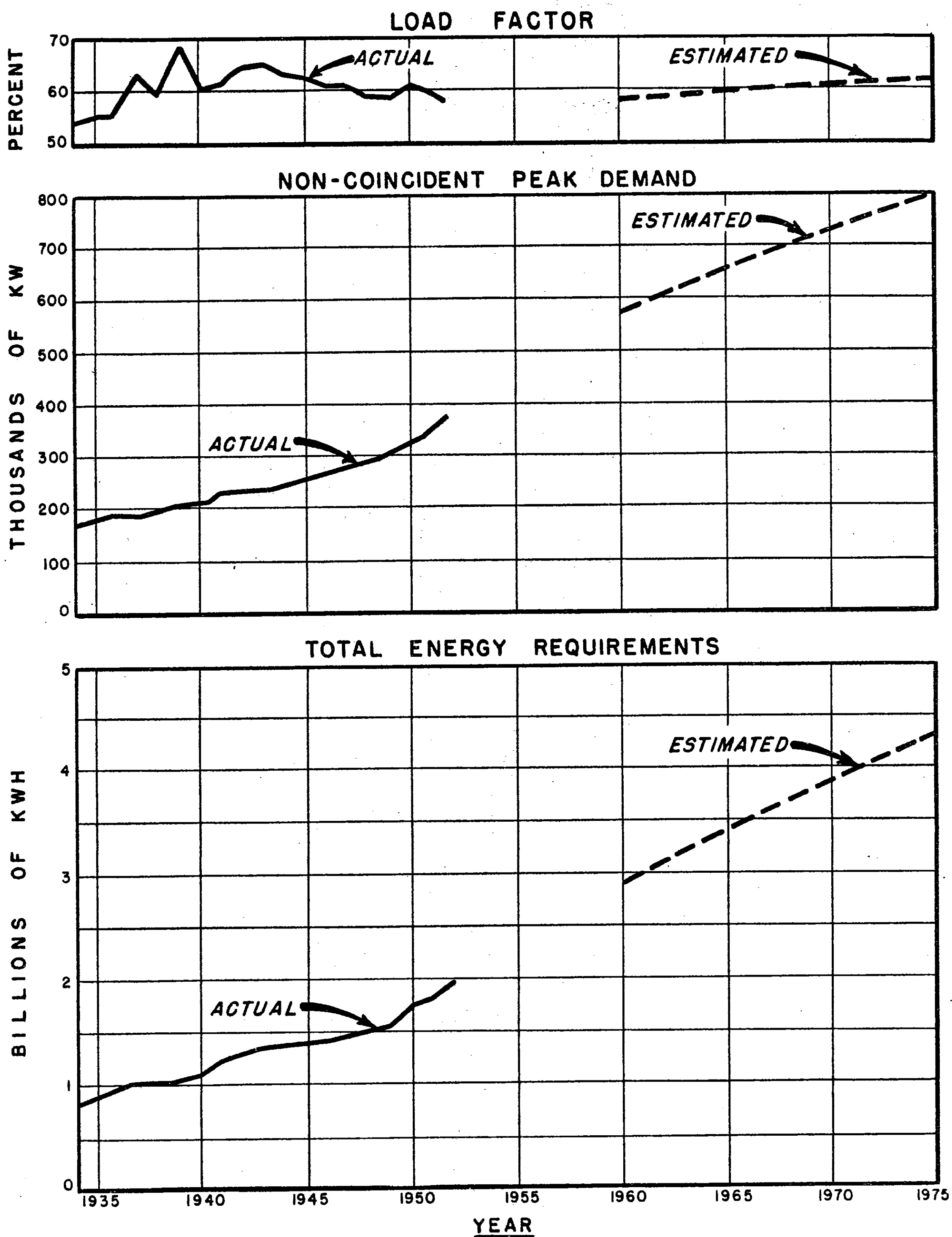
PAST AND ESTIMATED FUTURE ENERGY
REQUIREMENTS OF ALL ELECTRIC UTILITIES
POWER SUPPLY AREA-1 (MAINE)

NEW ENGLAND NEW YORK INTER-AGENCY COMMITTEE

SEPTEMBER 1954

SCALE AS SHOWN

FPC-NEW YORK, SEPT. 1954



SUBREGION "A"

PAST AND ESTIMATED FUTURE POWER REQUIREMENTS

POWER SUPPLY AREA-I (MAINE)

NEW ENGLAND NEW YORK INTER-AGENCY COMMITTEE

SEPTEMBER 1954

SCALE AS SHOWN

FPC - NEW YORK, SEPT. 1954

PLATE 3
CHAPTER II

hour figure of 1952 to 2,930 million in 1960 and to 4,280 million in 1975, increases over 1952 requirements of 51 percent and 120 percent respectively. Annual peak loads are expected to grow from 385,000 kilowatts in 1952 to 575,000 kilowatts, or by 49 percent, in 1960 and to 800,000 kilowatts, or by 108 percent in 1975. Past and estimated future capacity and energy requirements of Maine are listed in Table 37 and shown on Plates 2 and 3. In addition to the future markets in Subregion "A" it is estimated that contiguous areas within Subregion "B" and the Provinces of Quebec and New Brunswick in Canada will in 1960 present markets for about 152,000 kilowatts of capacity increasing to about 290,000 kilowatts in 1975. All estimates are predicated upon continuance of a peacetime economy without radical spurts in electrical requirements through exploitation of certain natural resources, the probabilities in the latter field being considered as speculative.

39. Existing electric generating facilities. - Future loads will obviously be met by the now existing and scheduled facilities which remain in service at the time plus new facilities not yet scheduled. The present dependable capacity of the subregion's existing utility generating plants totals about 432,000 kilowatts, 208,000 kilowatts or 48 percent in 57 hydroelectric stations and 224,000 kilowatts or 52 percent in 26 fuel-electric stations. Over 67 percent of this total capacity is concentrated in 12 large

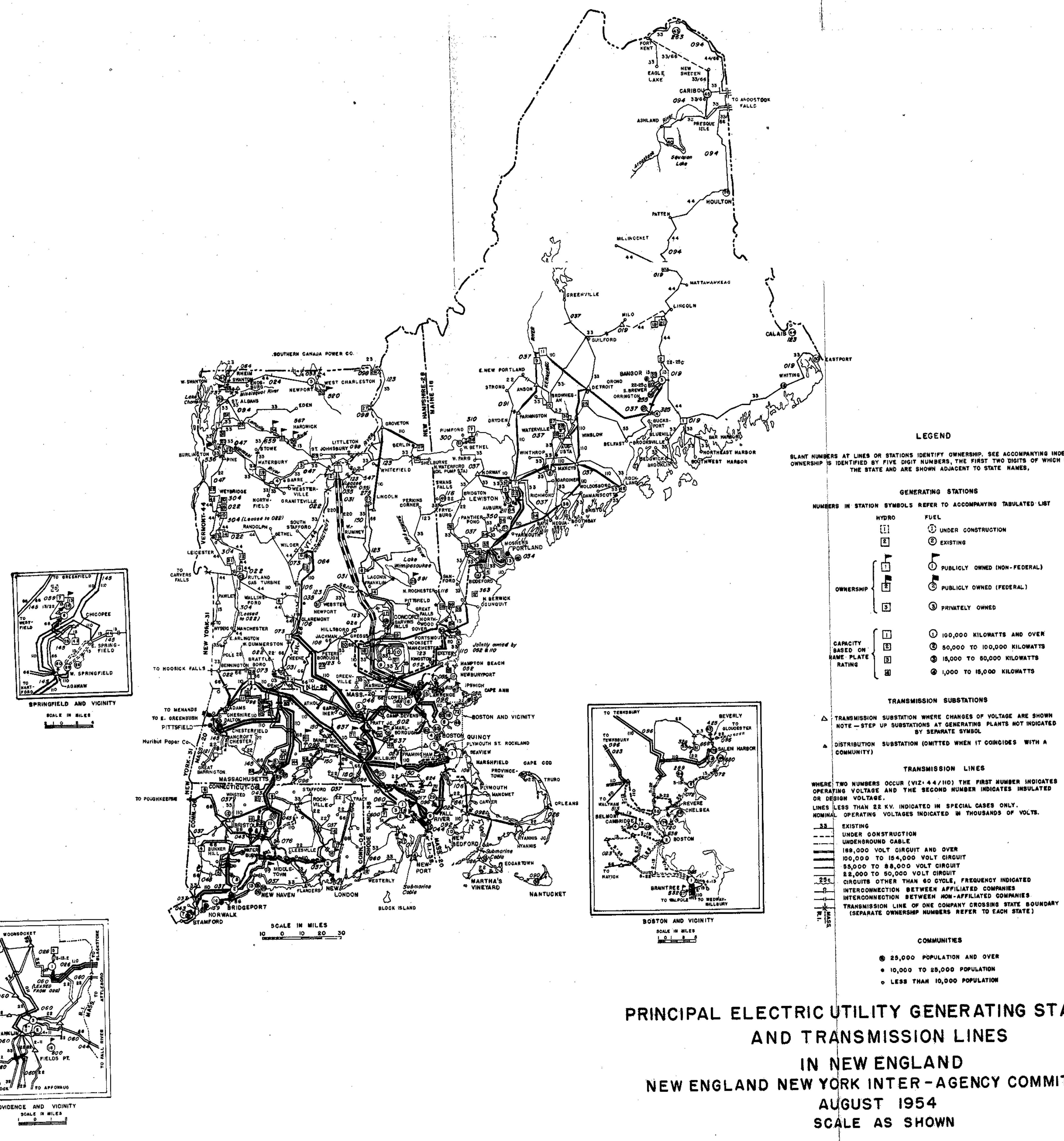
stations. The energy requirements of the area have in the past been met predominantly by the water-power plants, average hydroelectric generation during the 1941-1952 period having been about 81 percent of the total.

40. It is not expected that appreciable retirements of hydro plant facilities will occur in the foreseeable future whereas substantial retirements of fuel-electric capacity through obsolescence and inadequacy are to be anticipated.

41. Non-utility, or industrial, generating capacity at the end of 1952 totalled about 289,000 kilowatts, 54 percent in 48 waterpower plants and 46 percent in 36 fuel plants. About 86 percent of this total capacity is accounted for by plants operated in the paper and pulp industry and 11 percent in the operation of textile mills.

42. Transmission system. - The transmission system serving Subregion "A" comprises about 339 miles of 110-kilovolt, single cicuit and 51 miles of double circuit lines, supplemented by 66-kilovolt and lower voltage lines. Inspection of the map (Plate No. 4 will reveal the manner in which the various generating stations, substations and load centers are tied into a well integrated statewide transmission network.

43. Estimated future needs for additional generating capacity. - On the basis of estimated utility load requirements in 1975, it would appear that Subregion "A" will need, in addition to now existing capacity which will then be available and capacity which



PRINCIPAL ELECTRIC UTILITY GENERATING STATIONS AND TRANSMISSION LINES IN NEW ENGLAND

NEW ENGLAND NEW YORK INTER-AGENCY COMMITTEE

AUGUST 1954

SCALE AS SHOWN

PLATE 4

FPC-NEW YORK - AUGUST, 1954

CHAPTER II

has been definitely scheduled to go into operation between now and 1975, dependable capacity and associated annual energy in the amount of about 275,000 kilowatts and 1,521 million kilowatt-hours in 1975. It appears that new capacity has been scheduled in such amounts that no new hydroelectric capacity will be required in 1960. The additional power required in 1975 takes into account the retirement of an estimated 57,000 kilowatts (25 percent of that now existing) of fuel-electric requirement by the year 1975. Reserves aggregating 15 percent of the expected peak loads are also allowed for. All estimates are based upon conditions existing during a year of adverse streamflow.

44. Possible utilization of the subregion's undeveloped water power. - Analysis of the inventory power plans to determine to what extent the characteristics of the developments, namely the capacities at the various sites and the associated energy under adverse streamflow conditions, could be utilized in meeting Subregion "A" utility requirements, indicates that of the additional 225,000 kilowatts needed in 1975 about 152,000 kilowatts could be furnished by projects included in the inventory power plans. In addition about 60,000 kilowatts could be utilized in Subregion "B" by 1975. It thus appears that the characteristics of the 1,236,000 kilowatts of undeveloped power in Subregion "A" would be such as to permit utilization within the United States of about 212,000 kilowatts or about 17 percent by 1975. This does

not imply that more extensive ultimate use of these resources is precluded. The year 1975 cannot well be assumed as marking the end of power market development in the various areas considered. That year was chosen in the belief that estimates carried further into the future are too speculative.

45. Power values. - Power values assigned to the capacity and energy made available by the inventory power plans have been determined on the basis of the costs of generating equivalent power by privately financed steam plants, these being considered the most likely alternative source of power in the absence of the hydroelectric projects. The at-site values are equal to the cost of steam generation, plus the cost of transmission from the steam plants to the market less the cost of transmission from the hydroelectric project to the market, with allowance for losses and other adjustments.

46. Alternative steam generating units have been selected with average size and thermal effeciency appropriate to the market area. These units range from 12,650 kilowatt capability and 14,200 B.t.u. per kilowatt-hour heat rates in southeastern Maine to 126,500 kilowatt units operating at 9,900 B.t.u. per kilowatt-hour in the Quebec urban area. Capital costs of the steam stations, varying from $165. to $191. per kilowatt, have been assumed on the basis of size, location and other pertinent factors. Cost of fuel has been set at levels varying from 36.6 to 48.2 cents per

million B.t.u. Assumptions with respect to annual fixed charges for alternative steam plants based on private financing, range between 10.7 and 11.9 percent of the capital costs.

47. All costs are based on 1949 price levels. For the purpose of this report the market for the subregion's undeveloped water power has been confined to load centers within Subregion "A" and nearby areas in Subregion "B" and Canada. Power values have been computed by river basins or parts thereof, and represent average values weighted in accordance with the capacity and energy allocated to each market area. These values are summarized in table 38. For a detail discussion, see Chapter XI, Special Subjects Subregion "A".

Table 38 - Composite at-site power values, Subregion "A"

River basin	Power values: Capacity (Dollars/kw-yr.)	Power values: Energy (Mills/kwh)
Saint John		
Fish and Aroostook Rivers	28.00	5.6
Saint John River (Rankin Rapids)	18.75	4.3
Penobscot	25.50	4.8
Kennebec	25.00	4.5
Androscoggin	27.50	4.3
Saco	27.75	3.8
Maine Coastal	27.75	4.9

ECONOMIC ANALYSIS OF INVENTORY POWER PLANS

48. Basis of cost estimates and annual fixed charges - The project cost estimates are based on 1949 price levels. They include the cost of dam and power facilities, acquisition of land,

reservoir clearing, relocation of existing highways and utilities, construction of access roads with adequate allowance for engineering, overhead and contingencies. The estimates of annual charges are based on private financing. They include (1) a return of 5.5 percent on the capital investment; (2) depreciation based on a sinking fund accumulating at 5.5 percent over a service life of 50 years; (3) allowance for insurance, and the replacement of major items of property estimated to have a useful life of less than 50 years; (4) Federal, State, and local taxes. Federal income taxes are based on the existing 52 percent tax rate, a 5.5 percent allowable rate of return and the projects financed through 50 percent mortgage bonds, and 50 percent equity capital. Annual fixed charges on investment employed in the economic analysis of the subregion's undeveloped water power projects are itemized in Table 39.

Table 39 - Estimated annual fixed charges - Hydroelectric projects Subregion "A"

Item	Percent of investment
Rate of return	5.5
Depreciation	0.4
Insurance	0.1
Replacements	0.2
Taxes	
Federal (income)	2.2
Federal (miscellaneous)	0.1
State and local	1.2 to 1.7
Total	9.7 to 10.2

49. Estimated annual operation and maintenance costs - Annual charges for maintenance and operation vary with the size of the installation. Such charges, including a 25 percent allowance for administrative and general overhead, have been estimated to range from $13.75 per kilowatt for plants of 2,500 kilowatt capacity to less than $2.00 per kilowatt for plants exceeding 120,000 kilowatts. With respect to storage-only projects annual operation and maintenance costs have been assumed as $20,000 for projects involving up to 50,000 acre-feet capacity with $1,000 added for each additional 25,000 acre-feet of capacity.

50. Comparison of benefits and costs - The benefits attributable to the inventory plans as shown in Table 40 were derived by applying the composite river-basin unit values shown in Table 38 directly to the capacities and average year outputs provided by the inventory plans for each of the basins. It will be noted that the benefits are confined to the power features of the plan. Studies indicate that no other monetary values relating to flood control, water supply, pollution abatement, etc., can properly be assigned to the inventory plans of this subregion. The estimated first costs, annual costs and benefit-cost ratios for the inventory power plans of Subregion "A" are also shown in Table 40.

51. It will be noted from an inspection of Table 40 that the benefit-cost ratios of the inventory plans for the several basins fall below unity except for the Saint John, where the ratio is

1.03 to 1. It must be remembered, however, that each one of these ratios relates to a group of projects and represents a mean or average ratio. Individual projects will show more or less favorable ratios. For example, the 75,000-kilowatt Indian Pond project in the Kennebec River Basin, one of the projects included in the inventory plan for that river basin is now being built by the Central Maine Power Company, although the benefit-cost ratio for the inventory plan for the Kennebec River Basin is less than unity. It is to be expected that other projects included in the inventory power plans will prove economically feasible as Subregion "A" and the adjacent territory develop as a market for electric power.

52. <u>Summary</u> - Subregion "A" possesses a potential water power aggregating about 1,700,000 kilowatts of which some 450,000 have been developed, leaving about 1,236,000 as the undeveloped hydroelectric potential. It is estimated that by the year 1975 the subregion will need about 225,000 kilowatts of capacity in addition to that which will be available from now existing and scheduled installations. The characteristics of the undeveloped hydroelectric power of the subregion are such that, if developed as shown by the inventory plans, about 212,000 kilowatts, or about 17 percent of the subregional undeveloped total of 1,236,000 5/ kilowatts, could be utilized within the United States by 1975. Markets for the remainder would exist to a limited and indefinite extent in nearby adjacent areas in upper New England, also possibly in

5/ Includes Ripogenus which is not included in the Inventory Power Plan of the Penobscot River Basin; and has not been adjusted for plant replaced at Madison.

Table 40 - Summary tabulation of pertinent data including estimated power benefits and costs - Benefit/cost ratios - Inventory power plans, Subregion "A"

River basin	Installed capacity 1/ (kw)	Average annual energy 1/2/ (1000 kwh)	Total first cost ($1000)	Annual cost ($)	Annual benefits ($)	Benefit/cost ratio
Saint John	255,500	1,002,400	87,330	9,206,900	9,479,900	1.03
Penobscot	309,500 3/	1,611,850 3/	221,175 6/	24,566,000 6/	13,383,700 6/	0.54
Kennebec 4/	461,000 5/	1,387,740 5/	171,198	19,042,800	17,769,800 5/	0.93
Androscoggin	92,500	462,010 7/	52,976	5,948,600	4,530,400	0.76
Saco	52,400	145,480	34,114	3,671,000	2,006,900	0.55
Maine Coastal	4,000	10,200	2,449	276,000	161,000	0.58
Total	1,174,900	4,619,680	569,242	62,711,300	47,331,700	0.75

1/ Total of new projects after deducting for existing plants replaced.
2/ Includes additional energy at existing downstream plants resulting from storage provided by the inventory plan without redevelopment.
3/ Includes Ripogenus Project currently under construction (36,000 kw-250,000,000 kwh), not in inventory plan.
4/ Includes Indian Pond project under construction. Ultimate capacity 75,000 kilowatts.
5/ Not adjusted for loss of existing installation at Madison, (10,470 kilowatts).
6/ Does not include Ripogenous.
7/ Includes 690,000 kwh at a redevelopable plant.

nearby Canadian areas. Benefit-cost ratios, which are used as a measure of economic feasibility, range less than unity and are reflected in a ratio of 0.75 for all projects in all basins combined. The effects of changes in cost levels, altered techniques in electric power generation, growth of power markets brought about by exploitation of certain natural resources of the subregion not presently utilized, the growth of the area's normal electric load requirements beyond the year 1975; some or all of these factors may throw a more favorable light on the economic feasibility and ultimate marketibility of the subregion's undeveloped hydroelectric power.

SECTION VIII - NAVIGATION AND BEACH EROSION

INTRODUCTION

1. The State of Maine has the greatest mileage of tide-water shoreline on the Atlantic Coast. The deeply fringed coast includes nearly a score of bays, the largest of which are Casco, Penobscot and Passamaquoddy. The major navigable rivers are the Kennebec, Penobscot, and the St. Croix. The complexly irregular coast may be divided into four topographic sections from southwest to the east. The first, or southwestern section extends from the New Hampshire State Line to Cape Elizabeth. The second section is formed by Casco Bay. The third, which may be termed the middle coast extends from Cape Small to the eastern bank of the Penobscot River. The fourth section or eastern section reaches from the Penobscot to Calais on Passamaquoddy Bay.

2. Tides, currents, winds and waves. - The tides along the coast of Maine are semidiurnal; that is, there are two high waters and two low waters each tidal day. The mean range of tide increases toward the northeast, the increase being gradual along the southern open coast and rapid along the northern shore where it enters the Bay of Fundy. The mean and spring ranges of tide vary from 8.8 and 10.1 feet, respectively, near the southwestern margin of the subregion to 18.2 and 20.7 feet, respectively, along the extreme eastern shore. The irregularity of the Maine coast, particularly north of Portland, does not permit any general movement of littoral drift in one direction;

and even to the south of Portland where the shoreline is more regular, existing evidence indicates that the principal littoral currents come from both the northeast and southwest. The prevailing winds along the coast of Maine are offshore from westerly quadrants. Onshore winds from the easterly quadrants occur only about one third of the time; however, these easterly winds are often of greater velocity than the prevailing winds. The average wind velocity is highest along the eastern section of the coast and is lowest along the southwestern section.

3. The shore of Maine is exposed to attacks by waves generated in the Bay of Fundy, the Gulf of Maine, and the Atlantic Ocean, which approach the shore across open expanses of water from the northeast, east, southeast, and south. Winds from the western quadrant produce waves generated across only short fetches in bays or other waterways. South of Penobscot Bay the shore is directly exposed to Atlantic Ocean waves. The northeastern portion of the coast is protected from the open ocean by Nova Scotia; however, it is exposed to waves approaching from the southeast. Ocean waves are modified and reduced in height by shoals on the continental shelf. Due to the high wind velocities and long duration of northeast storms, wave attack across the more limited fetches to the northeast can be very violent. Large areas of the Maine shore are afforded shelter from ocean waves by the topographic features of the coast such as islands and promontories.

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NAVIGATION

4. Rivers and harbors. - From the Piscataqua River northeast to Cape Elizabeth, there are many low, flat shore beaches with long stretches of white sand and river marshes, broken by occasional jutting rocky headlands. This stretch of shore is pierced by several small rivers, but only the York, Kennebunk, Saco and Scarboro are significant for navigation. The mouth of the York offers one of the best small boat harbors in this resort area, and further east, the lower reaches of the Kennebunk offer well protected although more shallow facilities. The Saco River is navigable for about 6 miles upstream from its mouth to the cities of Biddeford and Saco, and Wood Island Harbor and Biddeford Pool at the mouth of the Saco offer harbor facilities. In addition to these, Cape Neddick Harbor, north of the mouth of the York, and Cape Porpoise Harbor in Kennebunkport, Wells Harbor at the mouth of the Webhannet River and Perkins Cove at the mouth of the Josias River provide small boat protection. There is no major harbor in this sixty mile stretch of shore. The wide beaches of fine white sand, coupled with relatively warm water, have turned this whole section of the Maine shore into a highly developed resort area, with its center of concentration in Saco Bay, a crescent indentation between the mouth of the Scarboro on the north and the Saco on the south.

5. Casco Bay, the second section of the Maine coast, lies within the arms of Cape Elizabeth on the west and Cape Small on the

east. In this section, the fine sandy beaches of the western section are replaced with small shingle beaches, and the shore is high although not rocky. A triple line of islands extends across the bay, protecting the inner reaches from the violence of the open sea. At the southwest corner of the bay lies Portland Harbor, the major port of Maine, and a commercial center for the northeastern New England area. Fore River empties into the bay at Portland Harbor, the lower reaches of the river forming a portion of the harbor itself. On the west side of the bay, and north of Portland, the Presumpscot and the Royal rivers empty into the bay. On the southern end of the long narrow peninsula known as Harpswell Neck, lies Potts Harbor, approximately in the center of the bay; and northeast of Potts Harbor, extending northward on the east side of Sebascodegan Island, lies the long, deep tidal inlet known as New Meadows River. On the east side of Casco Bay lie Sebasco and Small Point Harbors. In addition to these, there are many island coves and harbors, the most significant of which are at Orrs Island, which lies east of and parallel to the southern part of Harpswell Neck, and at Mackerel Cove, on Bailey's Island, southeast of Harpswell Neck. Among the numerous islands of the bay, there are many protected passages and sounds.

6. The third section of the Maine coast, extending from Cape Small on the west to the eastern shore of the Penobscot, may be subdivided into the area extending from Cape Small eastward to Owls Head Harbor on the western side of the entrance to Penobscot Bay,

and Penobscot Bay itself. From Cape Small eastward to Penobscot Bay, the coast is corrugated by a series of rivers and rocky peninsulas, which stretch toward the south. At the western end of this section lies the Kennebec, the second largest river entirely within Maine. It is navigable northward to Bath, above which it conjoins with the Androscoggin at Merrymeeting Bay. Above the bay it is navigable through Richmond, Gardiner, Randolph and Hallowell to Augusta which is 42 miles upstream. Eastward of the Kennebec, lies Sheepscot Bay, Boothbay, Linekin Bay, Johns Bay, and Muscongus Bay receiving the Sheepscot River, Damariscotta River, Johns and Pemaquid Rivers; and the Medomak, Meduncook, and St. George Rivers. It has been these rivers, particularly in the days of earlier commercial development, which have given such towns as Wiscasset, Newcastle, Damariscotta, Waldoboro, and Thomaston their easy access to the sea. In addition to the navigation facilities offered by these many rivers, this section of the coast offers a variety of harbor facilities, of which Southport, Boothbay, New Harbor, Port Clyde, and Tenants Harbor are representative and numerous protected inlands passages.

7. At the eastern end of the middle section of the coast lies Penobscot Bay, the largest bay along the coast of Maine. The entrance to the bay between Owls Head on the west to Isle au Haut on the east is about 20 miles wide. The bay reaches inland about 28 miles from this entrance to the mouth of the Penobscot, the principal river of Maine. The entire bay is divided into West and East Penobscot Bays

by a line of large and small islands of which Vinal Haven Island in the approximate center of the bay entrance, and North Haven Island, immediately to its north are the largest, although Long Island, near the head of the bay is the longest. The Penobscot River, emptying into the head of the bay, is navigable to Bangor. The west shore of Penobscot Bay is dotted with a series of ports, the principal ones, south to north, being Rockland, Rockport, Camden, Belfast and Searsport. In addition to these commercial harbors, the central islands of the bay and those numerous islands extending northward from Isle au Haut on the eastern side of the bay as well as the eastern shore of the northern section of the bay offer a variety of small fishing and recreational harbors.

8. From the eastern shores of Penobscot Bay through Passamaquoddy to the St. Croix River lies the easternmost section of the Maine Coast. This is the coast of towering headlands and deep bays, Blue Hill, Frenchman, Englishman, Machias, and Passamaquoddy, and many smaller, narrow deep bays such as Union River Bay, Gouldsboro, Dyer, Pigeon Hill, Narraguagus, Chandler, and many others. In this section of the coast is Mount Desert Island, famous as a summer resort, lying between Blue Hill Bay on the west and Frenchman Bay on the east.

9. At the northern extremity of the coast, lies the St. Croix River, forming a part of the international boundary between the province of New Brunswick, Canada, and the State of Maine, flowing southeasterly for about 100 miles to empty into Passamaquoddy Bay,

and navigable to the port of Calais. In the same area lies the port of Lubec, on Lubec Channel, and the port of Eastport, on Friar Roads, a section of the principal approach to Passamaquoddy Bay and the St. Croix River.

10. Waterborne commerce. - Since colonial days, waterborne commerce has fostered the development of Maine's economy. Early commerce in Maine consisted chiefly of the export of such products as pipe staves (wood for the manufacture of oil and wine casks), clapboards, fish, fish oil, and salt fish, but this commerce soon gave way to the more important exports of masts and timber. Between the end of the Revolution and the War of 1812, circumstances were ideal for the advancement of lucrative trade. Although the war created temporary difficulties, commerce continued to expand and by 1848 the number of vessels in foreign trade ran well into the hundreds.

11. Among the principal foreign and coastwise imports around the middle of the nineteenth century were molasses, sugar, flour, corn, slate, iron and coal. Lumber shooks, agricultural produce and ice were a few of the chief exports. Checked temporarily by the effects of the panic of 1857 and the Civil War, Maine commerce increased steadily thereafter, reaching a peak around 1872 when the total value of imports and exports at Portland alone was $45,000,000. Bangor exported $4,000,000 worth of lumber, and Rockland exported more than 1,000,000 casks of lime. From 1872 on, however, for a variety of reasons, Maine commerce began a slow but certain decline.

12. Today waterborne commerce in Maine consists of coastwise, intercoastal, and foreign traffic, the latter now relatively minor. Coastwise bulk traffic consists primarily of petroleum products, coal, fish and fish products, and pulpwood, lighter coastwise traffic having been to a large extent replaced by rail and highway transportation. The State has little bulk cargo for the support of foreign shipping at the present time.

13. The total reported waterborne commerce in Maine for 1952 amounted to 13,443,603 tons of which 11,302,202 tons were handled at Portland Harbor, 789,930 tons at the Penobscot River, 731,628 at Searsport Harbor, 287,587 tons at the Kennebec River, 108,344 tons at Eastport Harbor, and the remainder at 14 smaller harbors, the largest of which was Rockland, with 94,603 tons. In addition to this reported commerce, many smaller harbors handled unreported amounts of shipping.

14. History of improvement. -,The recorded history of improvement to the rivers and harbors of Maine dates back to the second quarter of the nineteenth century. The early projects dealt largely with channel improvement through removal of obstructions. Improvement in Portland Harbor began with the adoption of the initial project in 1836. During the third quarter of the century, while Maine waterborne commerce was still at its height, navigation improvements consisted largely of the removal of obstructions and the dredging of relatively shallow channels. In the last quarter of the nineteenth century, commercial development and changing navigational needs

brought with them the first major period of federal improvement to Maine rivers and harbors. Through the 1880's and 1890's, a series of Federal projects provided for channels in many rivers and harbors with depths varying from 6 to 22 feet. Throughout the 1890's, improvement continued not only with work on projects already authorized, but with the adoption of further projects.

15. Virtually all improvement occurring within the first 35 years of the present century was undertaken prior to 1913. Numerous channels and anchorages were dredged to depths of 12 to 15 feet. By the second quarter of the present century, the growing use of the deep-draft vessels required deeper channels and anchorages in the heavily utilized harbors, especially Portland. Other recent improvements have been necessitated by the growth in popularity of recreational boating and the ever important requirements of fishing craft.

16. Navigation plan. - The navigation plan for Subregion "A" consists of the completion of authorized projects in the Maine Coastal Area at Portland Harbor; Beals Harbor; channel between Isle au Haut, Hendricks Harbor, Scarboro River and Wood Island Harbor; Biddeford Pool; the Lubec Channel improvement; and ~~17~~ 19 authorized studies.

17. Costs. - The estimated completion cost for improvements at Portland Harbor, Beals Harbor, channel between Isle au Haut and Kimbal Island; Hendricks Harbor; Scarboro River; Wood Island Harbor and Lubec Channel is ~~$1,659,700.~~ 1,744,700 The estimated total cost

for studies is $47,500. The annual charges for all seven projects would be about $87,000. The estimated costs for individual projects are given in Table 41.

18. Benefits. - The benefits from the improvements at Portland Harbor are largely intangible as are also the benefits from Hendricks Harbor and the channel between Isle au Haut and Kimbal Island. A more detailed discussion of the intangible benefits is given in Chapter X, Maine Coastal Area.

19. Tangible benefits would accrue from the other four improvements. At Beals Harbor annual benefits from the prevention from loss of vessels, reduction of vessel damage, elimination of delays to local lobstermen and to lobstermen presently based elsewhere are estimated to be $11,200. At Scarboro River the reduction of delays to lobstermen, increase in fish catch and cannery facilities, and increased boat construction would create an annual benefit estimated to be $39,000. The benefits from the completion of the Wood Island Harbor project including the construction of 15 new boats and their use, elimination of delays, reduction in vessel damage and increased business would have an estimated value of $22,000 annually. At Lubec Channel the proposed improvement would provide protection to vessels and harbor facilities resulting in annual benefits of about $7,500. The benefit cost ratio of these four projects taken together is 3.3 to 1.

20. Since the beginning of Federal improvement in Maine, the United States has expended $11,000,000 for the benefit of general

Table 41 - Cost of navigation improvements, Subregion "A"

Project	Item of work	Estimated cost 1949 1/	Annual charges	Estimated cost 1953 1/
Portland Harbor	Ledge removal off Portland Head Light	$ 85,000		$ 112,000
	35-foot House Island Anchorage	1,155,000	$60,000	1,475,000
	Removal of hard shoal in 35-foot channel	67,500		90,000
Beals Harbor	10-foot Anchorage	105,000	5,200	132,000
Channel between Isle au Haut & Kimball Island	6-foot channel	50,000	3,000	64,000
Hendricks Harbor	Ledge removal in 9-foot entrance channel	9,500	400	14,000
Scarboro River	8-foot channel and 6-foot channel and anchorage	145,000 2/	9,600	197,000 2/
Wood Island Harbor & Biddeford Pool	6-foot basin and 3 ice breakers	77,000 3/	6,500	112,000 3/
Lubec Channel	Extend Gun Rock Breakwater 90 feet and construct breakwater 385 feet long at Short Point	50,700	3,000	74,000
	Totals:	$1,744,700	$87,700	$2,270,000

1/ Based on Federal construction
2/ Includes $10,000 local contribution
3/ Includes $12,000 local contribution

navigation in Maine waterways. Of this approximately $9,500,000 has been for the improvements and the remainder for maintenance. Of the total costs to the United States, about 30% has been expended on Portland Harbor and 16% on the Kennebec River. A more detailed discussion of navigation projects is contained in Chapter XI, Special Subjects, Subregion "A" and Section VIII of Chapter X, Maine Coastal Area.

21. Beaches. - The principal beach developments on the coast of Maine are along the southwestern shore between the Piscataqua River and Portland. The majority of these are sandy barrier bars or spits fronting marsh areas. The most important stretches of beach south of Portland are Seapoint Beach in Kittery Harbor; Long and York Beaches in York; Ogunquit, Moody and wells Beaches in Wells; Kennebunk Beach and Goose Rock Beach in Kennebunkport; Fletcher Neck and Hill Beaches on the south side of Biddeford Pool; Ferry, Old Orchard and Pine Point Beaches between the mouth of the Scarboro River and the Saco River; Scarboro and Higgins Beaches in Scarboro; and Crescent Beach on Cape Elizabeth. The major beach in Portland is East End Beach.

22. Seapoint, York, Ogunquit, Kennebunk, Ferry and East End beaches are publicly owned by the towns or cities in which they are located. Moody, Wells and Goose Rock beaches are used publicly although developed privately. These sandy beaches, consisting of unconsolidated material, are particularly susceptible to erosion.

North of Portland there are three well-known beaches in the town of Phippsburg. They are Small Point, Hunniwell, and Popham beaches. There are two others, Popplestone and Sandy River beaches, in the town of Jonesport. In addition, there is a public beach at Reid State Park in Georgetown.

23. Shore protection. - The extremely rocky and rugged character of the greater part of the Maine coast line has made problems of beach erosion a matter of much less serious concern to the State of Maine than to her sister states on the coast of New England. The only problems of concern exist in the sandy stretches of beach between Portland and the Piscataqua River. There has been one cooperative study of Old Orchard Beach, and a preliminary examination of the Saco River in regard to erosion problems in the Camp Ellis and Ferry Beach areas. More recently, the State of Maine has indicated a desire to initiate a cooperative beach erosion control study of the entire shore within York County, with particular emphasis on the Saco Bay region within which Ferry and Old Orchard Beaches lie.

24. Only limited information is available concerning shore protective structures provided privately or by towns. A few of the towns in the beach area south of Portland have undertaken beach protection measures by the placing of riprap and sea walls. To date there has been no Federal assistance in the construction of shore protective works. However, various structures built by the Federal Government in connection with navigation improvements have probably

provided some protection to adjacent shore areas. A more detailed discussion of beach erosion is contained in Chapter XI, Special Subjects, Subregion "A".

SECTION IX - FISH AND WILDLIFE

1. Wildlife resources. - Throughout the area included in the river basins and coastal area which comprise Subregion "A", there is considerable uniformity in the species of game available to the hunter. None of the other subregions offers a forest-game resource of such magnitude and homogeneity. Farm-game animals, such as cottontail rabbits and ring-necked pheasants, are poorly distributed in this area, being absent over most of the subregion. Pheasant hunting, although popular in southern Maine, is sustained only by continual introductions of artificially reared birds. There exists of course a wide diversity of habitat conditions in this area, but the final products of the wildlife environment all fall within the category of forest game, rather than farm game.

2. The distribution of productive habitat for waterfowl and fur bearers is rather general throughout the subregion. Each river basin contains certain productive niches, especially with regard to waterfowl and muskrats, but few areas of great significance are found. The subregion might best be characterized as being important for waterfowl insofar as its aggregate production is concerned, but possessing few extensive areas of superior habitat. Many coastal areas are also very important from the standpoint of providing excellent wintering grounds for waterfowl. The area in and about Merrymeeting Bay is especially important from the standpoint of hunter utilization.

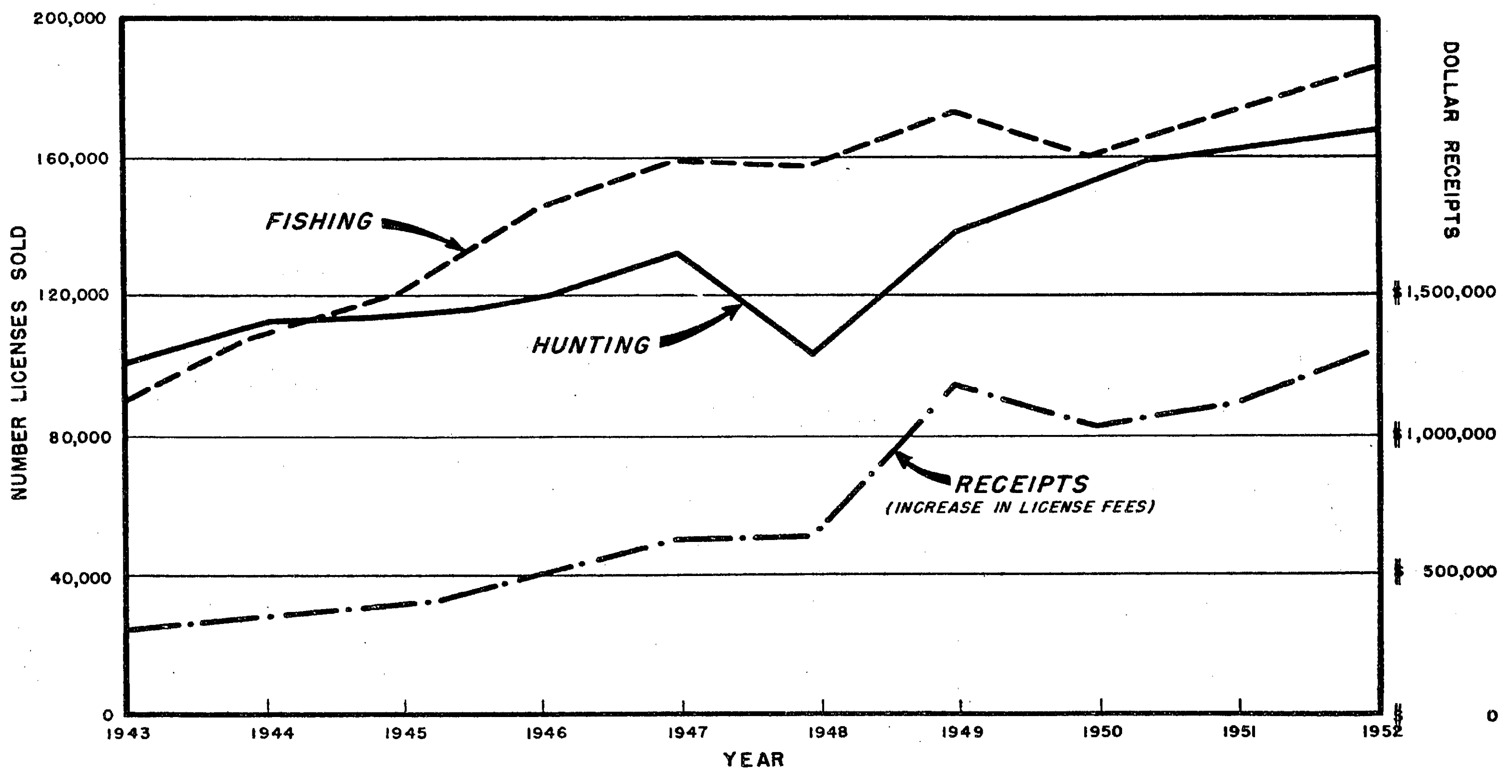
3. The fish and wildlife resources contribute a great deal to the general economy in Subregion "A". Especially in such areas as northern New Hampshire and northern and eastern Maine, the existence of good quality hunting and fishing in attractive, uncrowded surroundings has resulted in the establishment of many facilities to accommodate sportsmen.

4. Without doubt the white-tailed deer is the most important wildlife species in the subregion. In connection with hunting for deer, it is probable that there are more devotees of this sport, more facilities available and more money spent than is the case with hunting for any other species. In recent years about 40,000 deer have been taken annually by hunters within the subregion. As noted in the economic survey of sportsmen's expenditures in Maine 1/, hunters in that State spent over 21 million dollars in 1952, exclusive of license fees. The addition of license fees and hunter expenditures in that part of New Hampshire lying within Subregion "A" would increase the total expenditures to over 22 million dollars. The importance of the deer resource is apparent when it is realized that deer hunters make up a large proportion of the total number of licencees.

5. Fishery resources. - Subregion "A" contains most of the cold-water lake and pond fishing in the New England-New York area.

1/ Job Completion Report, Project No. W-37-R-2, Maine Department of Inland Fisheries and Game, Augusta, Maine, 1953.

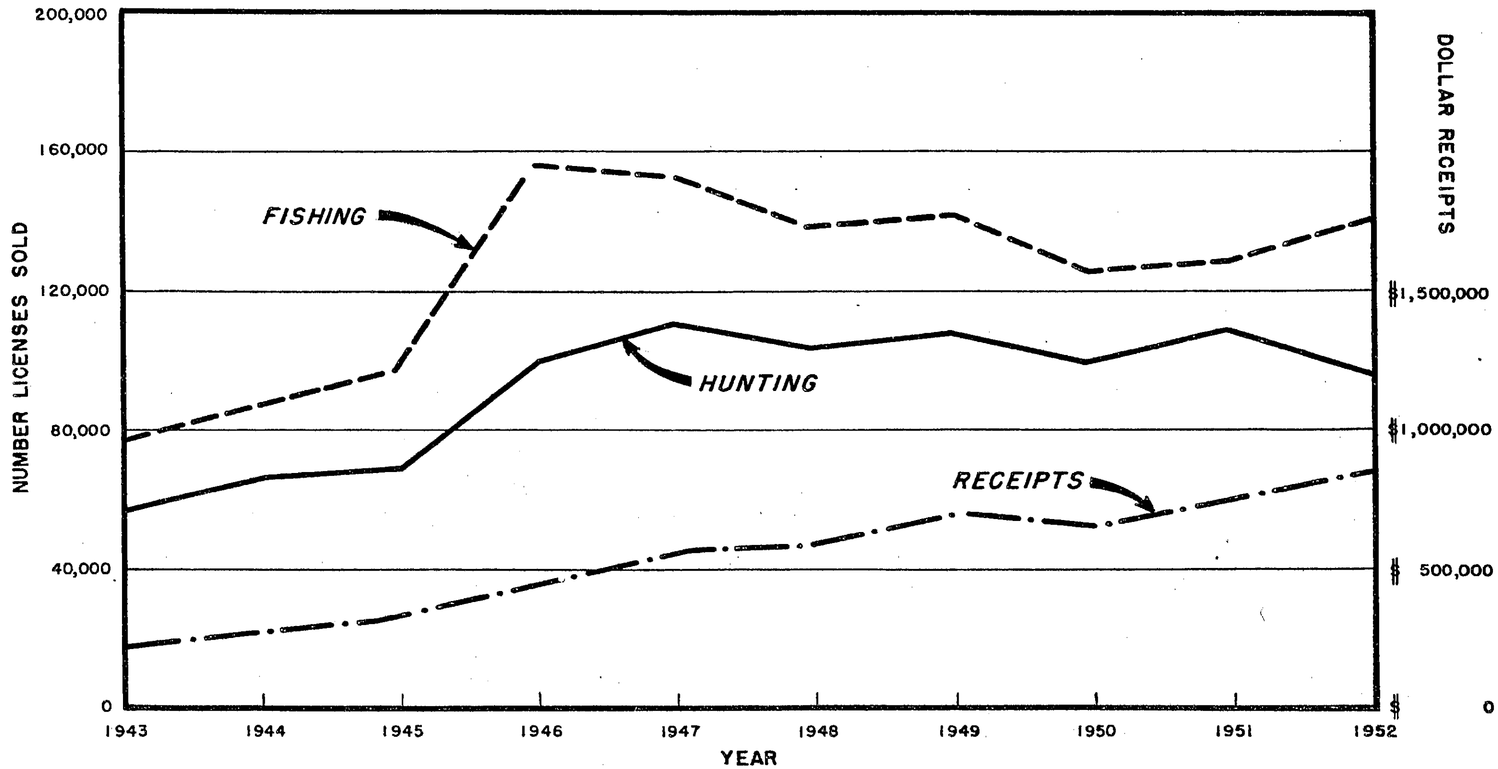
Trout water in a wilderness setting - East Branch Penobscot River, Maine. Subregion "A".



SUBREGION "A"
HUNTING AND FISHING LICENSE
SALES AND RECEIPTS
STATE OF MAINE
NEW ENGLAND NEW YORK INTER-AGENCY COMMITTEE
AUGUST 1954
SCALE AS SHOWN

PLATE 5
CHAPTER II

D. OF I. F&W SERV. BOSTON, AUGUST 1954



SUBREGION "A"
HUNTING AND FISHING LICENSE
SALES AND RECEIPTS
STATE OF NEW HAMPSHIRE
NEW ENGLAND NEW YORK INTER-AGENCY COMMITTEE
AUGUST 1954
SCALE AS SHOWN

PLATE 6
CHAPTER II

D. OF I. F&W SERV. BOSTON, AUGUST 1954

Lake fishing for brook trout, lake trout, and landlocked salmon is found all the way from Sebago Lake in southern Maine to the Fish River Lakes in northern Aroostook County, and from the Rangeley chain of lakes in western Maine to the Schoodic Lakes in eastern Maine. Ponds which provide warm-water fishing for such species as smallmouth black bass, chain pickerel, white perch, and yellow perch are common throughout the subregion except in northern Maine. Lake fishing for trout and salmon is probably the most important type of sport fishing in the subregion. The most popular lake fishing areas for trout and salmon consist of Sebago Lake in the Presumpscot River Basin, the Rangely Lakes in the Androscoggin River Basin, lakes draining into the Moose and Dead Rivers and Moosehead Lake in the Kennebec River Basin, the northern wilderness lakes and Fish River Lakes in the Saint John River Basin, the lakes of Hancock County draining into the Union River Subbasin, and the Schoodic Lakes in the St. Croix River Basin.

6. Pond fishing for warm-water fish species is gaining in importance throughout much of the subregion. The most important reasons for this trend are the influx of large numbers of vacationists during the summer season when cold-water lake fishing is at its poorest, and the deterioration of habitat for cold-water fish species in many lakes in the subregion. Important areas for warm-water fishing include many lakes in the Saco,

Presumpscot, and Androscoggin River Basins where highly developed summer camp areas are found, the Belgrade Lakes and lakes drained by the Sebasticook River in the Kennebec River Basin, a large number of lakes in the central portion of the Maine Coastal Basin, and several large lakes in the St. Croix River Basin.

7. Stream fishing for brook trout is highly popular throughout all segments of the subregion. This species of fish is found in the streams of all the basins, from the Saco to the Saint John. Stream fishing pressure is low only in the remote regions of northern and eastern Maine. Trout fishing, as well as angling for other species, is of little account in the large rivers. Dams, pollution, and high temperatures are factors which have reduced or eliminated the fisheries of the large rivers, including the once important runs of anadromous fishes, such as Atlantic salmon and shad. It is only in northern Maine that high quality river fishing for the choice cold-water species exists in fair amount. The Allagash, Aroostook, Kennebec and Saint John Rivers afford excellent trout fishing and first-rate canoeing in wilderness surroundings. The east Branch of the Penobscot River likewise provides fine quality canoeing and trout fishing. With the possible exception of the Machias River in eastern Maine, the above waters provide all the important canoe-fishing trips on rivers in Subregion "A".

8. The economic survey of sportsmen's expenditures in Maine reveals that resident fishermen spend about 16 million dollars

in pursuit of their sport in Maine each year. This total is exclusive of license fees and expenditures of minors who need not purchase licenses to fish. Also not included are the expenditures of anglers utilizing that part of Subregion "A" lying in New Hampshire. This annual expenditure includes direct costs of angling to the fishermen, such as transportation, food, and lodging, fishing tackle, boats and motors, clothing, guide fees, and miscellaneous expenses. It must be added that the quality of fishing offered in the subregion has been an important factor in stimulating the construction of cottages, establishment of organized boys' and girls' camps, and the growth of various service enterprises, such as stores, restaurants, service stations, etc.

9. Economic aspects. - The economic survey of expenditures by fishermen and hunters in Maine reveals that the amount spent annually for these pursuits would rank sport fishing and hunting as the third or forth major industry in Maine. According to this study, the recreational value of the fish and wildlife resources is exceeded only by that of textiles and manufactured mill products, paper and allied products, and possibly leather and leather products. In view of the fact that the portion of Subregion "A" contained in New Hampshire has only Berlin as an important industrial community would indicate that hunting and fishing occupies a similar position of importance in that area of the subregion.

10. In addition to the sporting value of fish and wildlife to the economy of Subregion "A", there exists an important commercial fishery resource in the coastal areas. Commercial fishery activities are discussed in Chapter XXXIX Special Subjects Regional but inasmuch as shellfish and lobsters are closely associated with river estuaries and coastal areas, the value of this segment of the resources to the subregion is summarized here. In 1950 lobsters, hard and soft clams, crabs, and mussels, and other coastal resources such as Irish moss and bloodworms contributed over eight million dollars to the fishermen of the coastal areas. Over seven and a half million dollars of this total were contributed by lobsters and soft clams.

11. With the exception of commercial fishery activities, the importance of fish and wildlife cannot be measured adequately through economic surveys. These surveys may be used as indices in relating the status of fish and wildlife recreation to other activities of a commercial nature, but the aesthetic values of fish and wildlife defy measurement. It has always been considered, and properly so, that these intangible values are very great, and become even greater as civilization advances and leisure time increases.

12. There is included below a summary of information acquired during the economic survey of the value of fish and wildlife to the State of Maine. It should be recognized that, while most of Subregion "A" is found in Maine, a considerable portion

of northern New Hampshire is also located in the subregion. Therefore, the values included below represent something less than the total values for Subregion "A".

a. The 145,905 resident hunting license holders made up of the 113,145 hunting, 30,883 combination and 1877 guides licenses, spent in Maine in 1952 approximately $18,000,000 or about $125 per license holder.

b. There were 23,925 nonresident big-game licenses purchased by hunters who hunted predominantly deer in 1952 and their total estimated expenditure in Maine was about $3,100,000 while killing 8,131 deer, or about $382 per deer killed. The expenditure was approximately $145 per license.

c. The licensed resident hunters and fishermen annually spend a total of approximately $35,000,000. This does not include expenses made by minors and persons who need not purchase a license to hunt.

d. The average expenditure of a resident hunter for deer hunting was determined to be $54 using the median and $86 using the mean. Expanding this to include all deer shot by resident hunters (27,040 deer) each deer cost between $290 when employing the median and $462 when employing the mean to compute expenditure for each deer tagged.

e. The 124,949 resident fishermen made up of 92,189 fishing, 30,883 combination and 1877 guides licenses spent in

Maine in 1952 about $16,233,370 or approximately $130 per license holder.

f. The average expenditure of resident small-game hunters was found to be $43 using the median and $74 using the mean.

g. Total license expense of the residents for hunting and fishing was about $542,000 and nonresident hunters paid $474,680 to hunt in Maine in 1952.

h. There was no survey made of the expenditure of the nonresident fishermen.

i. The salaries of the guides in 1952 in the State of Maine was in excess of one-half million dollars, the great part of which was paid by the nonresident sportsman.

j. Sporting camps have been operating in unorganized territory for more than one hundred years, and in 1952 the estimated gross was in excess of $1,500,000.

k. Sporting camps which were licensed to operate in unorganized territory (124) have a value in excess of two million dollars and have total accommodations for about 4,200 persons. No information is available concerning the facilities in organized territory.

13. Plates Nos. 5 and 6 illustrate the upward trend in the number of hunting and fishing license sales and receipts from the sales, pertaining to the two states represented in Subregion "A".

It will be noted that the numbers of licenses sold have approximately doubled, and that receipts have increased at even a greater rate over the 10-year period illustrated. This disproportionate increase in dollar income results from the fact that license fees have been increased.

NEEDS OF THE FISH AND WILDLIFE RESOURCES

14. The increases and improvements in commerce, industry, and agriculture which have resulted in greater leisure time for the enjoyment of the fish and wildlife resources, have also created many problems in their management. Water pollution is considered to be accepted practice with regard to the downstream reaches of the larger rivers. Dams and reservoirs have disrupted and often destroyed the productivity of stream systems and certain bottomlands. Unwise introductions of exotic fish species have rendered many lakes unproductive of choice native species. Poor agricultural and forestry practices, especially in past years, have sometimes caused gross damages to fish and wildlife environment.

15. The problems outlined above are among those discussed in the following paragraphs. A solution to these problems would aid materially in meeting the needs of the increasing numbers of sportsmen who utilize Subregion "A".

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16. In Subregion "A", there is a total of about 575 miles of streams which are considered to be damaged by pollution to such an extent that fish and wildlife habitat has almost ceased to exist. Generally, the most seriously polluted segments of the watercourses are found along lower reaches of both the main-stem rivers and their major tributaries. In this subregion, areas of pollution are mostly located on reaches of rivers which are otherwise unsuited for high production of choice cold-water fish species. Elimination of the pollution menace, as a single improvement measure, would not necessarily bring about great benefits with regard to brook trout and landlocked salmon fishing. Often these polluted reaches are inadequate because of dams and reservoirs, high water temperatures, poor flow conditions, and competition by the less desirable fish species.

17. Pollution abatement, as a single improvement measure, would benefit the cold-water fisheries in the relatively few areas where this menace is the prime deterrent to high quality fishing. Pollution abatement alone would frequently benefit warm-water fish production and would make possible the opening of many shellfish beds in coastal areas of the subregion.

18. The pollution problem has added significance with regard to runs of anadromous fishes such as sea-run salmon and shad; but the abatement of this pollution would be of little advantage unless outmoded dams are destroyed, fishways are constructed or improved at other barriers, and flows are improved.

19. The effect of dams on resident, cold-water fishes has received less attention than the effect on anadromous species. In the various basin chapters the role of dams and reservoirs in damaging the inland fishery resources has been described in detail. Studies which have been carried out by personnel of the Maine Department of Inland Fisheries and Game have demonstrated the losses which can be expected by creating barriers between important spawning streams and lake systems. Also, in certain areas, reservoirs have eliminated important game-producing areas. This is a circumstance which may be encountered whenever a reservoir is created, but it should be added that a careful selection of sites might make it possible to avoid the flooding of the most valuable wildlife areas. Restrictions on water-level fluctuations and creation of sub-impoundments would occasionally offer possibilities of compensating for these losses.

20. In the river basins found in Subregion "A", there exists the need for attaining a solution to the urgent problem of severe competition by the less desirable fish species in lakes which offer good habitat for the favored trout and salmon. Such species as smallmouth black bass, chain pickerel, and white perch are valuable assets in many waters in Subregion "A", which are physically unsuited for the production of the more popular trout and salmon. These same fishes are generally considered totally undesirable, however, when they are introduced or somehow

encroach on the habitat which is favorable for the production of trout and salmon. As brought out in the basin chapter, there has been developed a program of eradicating mixed fish populations in certain small ponds and replanting these ponds with trout. Reclamation of the larger lakes by poisoning is often expensive and impracticable, however, and other techniques must be employed in order to achieve better environmental conditions for the trout and salmon. Some suggestions for possibly attaining better conditions for cold-water fishes in lakes which have suffered from introductions of warm-water species have been included in the river basin chapters of this report.

21. Harmful alterations in the various types of habitat attractive to the native forest-game animals have been far less widespread and generally of less severity than in the case of the fishery resources. A varied and intensive utilization of water resources has been a characteristic of Subregion "A" since pioneer days. This utilization has frequently resulted in damages to the fishery resources. The use of land resources by agricultural and woodlands activities, however, has not always had deleterious effects on wildlife habitat. Vast acreages have been kept in transitional stages of forest growth, and the impact of civilization has resulted in a greater diversity of vegetative cover on the land. With the exception of certain

species, such as the caribou, mountain lion, wolverine, and timber wolf, all of which have been extirpated from the area, much of the original fauna remains fairly abundant.

22. The chief problem with regard to wildlife in Subregion "A" is to assure the maintenance of continued supplies of game for the ever-increasing numbers of sportsmen. Although the general picture of wildlife abundance seems promising in this area, there exist indications that management and development programs are needed. There is a need for greater coordination between wildlife management and woodlands activities of the timberland companies. In that part of Subregion "A" lying in New Hampshire, there exists a program wherein the harvesting of timber is closely supervised on important deer-wintering areas. An extension of this program over all of Subregion "A" would be beneficial.

23. Wherever opportunity exists, there should be additional development of small marsh areas for wildlife. Nearly all elements of wildlife benefit from such developments, and waterfowl and muskrat populations respond especially well when these small wetland areas are created.

24. There is a lack of utilization of the wildlife resources over broad expanses in the northern portions of this subregion. These heavily forested segments of northern Maine are not especially attractive to the small-game hunter, but fair deer hunting possibilities exist in these areas. Many more hunters could be encouraged to utilize these northern areas if such

access roads as exist were fully open to the public and if more were constructed. An understandable fear of the forest-fire menace has tended to limit camp developments in this area, and access is denied to sportsmen when hazardous conditions prevail. Greater utilization of this area would be a benefit to sportsmen, and this greater use should be possible when the threat of fire is not high. Additional forest-fire patrol teams could police these areas during hunting seasons.

25. Considerable benefits to wildlife have accrued from the enforcement of sound game laws. Research investigations of various types are being carried out in order to formulate the best possible legal regulations for the taking of game and fur-bearing species. Perhaps the greatest need at the present time is to effect a solution to the problems of illegal deer hunting and the killing of deer by dogs. Large numbers of deer are not available to the lawful hunter because they are being taken through illegal means. The education of the youth of the area in proper conservation may offer the best solution to this problem.

26. Much investigation of the problem of wildlife management on agricultural lands has been conducted in recent years, and management techniques have been developed. The management of forest wildlife habitat has generally lagged because of the extensive land units involved. Likewise, in regard to fishery investigations, there have been established various measures for

studying and managing individual waters, but a basinwide approach to fishery problems has seldom been attempted except at salmon restoration projects in the Pacific Northwest. A worthwhile project in Subregion "A" would be the selection of a medium-sized river basin for intensive management of the fish and wildlife resources.

27. The Machias River Basin in eastern coastal Maine offers excellent opportunities for experimentation in basinwide fish and wildlife management. Fish and wildlife problems exist in the basin which are representative of those encountered in many portions of the northeast, but the degree of development of these problems is not so far advanced as to render a course of study and management impracticable. This basin offers splendid opportunities for a practical program of Atlantic salmon restoration. The area of 495 square miles provides a sizable working unit for salmon restoration, and the main stem river is crossed by only three small barriers near its mouth. Pollution is not a serious deterrent to salmon restoration anywhere along the free-flowing segments of the river.

28. Factors to be considered in a salmon restoration program in this basin include a solution to the problem of stream barriers, such as fishway construction, possible purchase of rights to maintain dams with a view towards possible elimination of one

or more dams, relocation of water supplies, and methods of financing the program. Also needed would be biological surveys of lakes and streams in the basin, low flow water regulation from upstream lakes, possible construction of spawning beds of rubble, control and supervision of fishing regulations, and possible changes in angling laws. Resident fish populations in lakes and streams would also be investigated in order that all elements of the fishery could be managed in the best possible manner.

29. From the wildlife standpoint, there would exist the opportunity to determine the feasibility of coordinating lumbering activities with wildlife management. Special regulations would govern the harvesting of timber on deer-wintering areas and other sites of special importance to wildlife. Correction of deficiencies in wildlife habitat would be possible in this basin through the establishment of special timber cutting techniques and the creation of marsh areas for waterfowl and fur bearers.

30. The intent of this suggestion for the Machias River drainage is not to discourage the development of land and water uses for resources other than fish and wildlife. Rather, it is believed that fish and wildlife management and particularly a program of anadromous fish restoration should be given an opportunity to prove its effectiveness in contributing to the economic welfare of this basin. In order to achieve this goal, special consideration must be afforded the fish and wildlife

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resources in the management of the land and water resources of the basin. In view of the fact that the Upper Holmes Falls power project has a low degree of feasibility, it would appear that serious barriers to anadromous fish restoration are not to be constructed in the foreseeable future. In view of this fact, and in view of the losses which would be sustained elsewhere in Subregion "A" by fish and wildlife if many units in the inventory power plan were to be constructed, it is believed that an experiment in fish and wildlife management is indicated for the Machias River drainage area in this subregion.

COORDINATION WITH OTHER LAND AND WATER DEVELOPMENT PROGRAMS

31. Throughout the chapters for the various river basins in Subregion "A" there has been emphasized the conflict between dams and reservoirs on the one hand and fish and wildlife on the other. It has been related that existing dams and reservoirs have greatly complicated efforts to manage properly the fish and wildlife resources. Under the inventory power plan, about 40 new dams would be constructed in Subregion "A" and many redevelopments of existing power projects may take place. The redevelopments would be located mostly along downstream reaches of the rivers and gross damages to fish and wildlife would not result. Damages, especially to fishery resources, are indicated at many of the new projects which have been described.

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32. The larger river basins in the subregion can be regarded as being comprised of three parts. The upstream part consists of head-water lakes and ponds, interconnected by relatively small streams. The middle portion consists of free-flowing, sizable rivers, as yet unpolluted and crossed by few or no barriers. The downstream part consists of the mainstem river which frequently is polluted and contains many dams and reservoirs. Except for a few storage reservoirs, the upstream part of the rivers in Subregion "A" would be undisturbed by power plans, and the downstream section would be affected only by redevelopments. It is along the middle portion of most of the river basins where power would be developed. Unfortunately, it is along this middle portion of such streams as the East and West Branches of the Penobscot, and the Aroostook Rivers where the finest canoe-fishing for cold water fishes in the New England-New York area is concentrated. Full development of the inventory power plan for the Saint John River would inundate 30 miles of the productive Saint John River and 36 miles of the lower reaches of the Allagash River. The Allagash River, being a wilderness tributary to the Saint John River, is productive throughout its length.

33. Much of the attraction of these canoe-fishing waters would be lost if the free-running reaches were to be inundated. Full development of the inventory power plans would reduce the mileage

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of the free-flowing segments of the various canoe trips as follows: West Branch Penobscot, 41 percent; East Branch Penobsoct, 62 percent; East Branch Penobscot-Seboois, 60 percent; Allagash, 53 percent; Saint John, 29 percent; and Aroostook, 40 percent. The physical destruction of these most attractive and productive sections of rivers would be a great loss to the fishery resources in Subregion "A". Moreover, it is not expected that the reservoir pools would offer an attractive fishery in the post-development period. The history of fishing in main-stem, run-of-the-river reservoirs in Subregion "A" provides slight promise that any new reservoirs would be an asset insofar as fishing is concerned.

34. It has been frequently mentioned in the course of this investigation that the cold-water stream fishery for trout and salmon might be replaced by a productive warm-water fishery for smallmouth black bass in most newly created reservoirs. There are three major objections to this possibility. Firstly, it must be understood that the reservoirs which would be formed, are mostly of the narrow, deep type, and factors such as water-level fluctuations and water temperatures would offer only sub-marginal habitat for such species as bass and pickerel. Secondly, it is obvious that introductions of warm-water species further into the headwater regions of these watersheds would result in the spread of these fishes into still other lakes and streams, where they

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would be clearly detrimental. Lastly, it should be recognized that local residents, and sportsmen who journey long distances to reach these cold-water areas, are attracted by the existing trout and salmon fishing. Smallmouth black bass certainly comprise a first-rate attraction in other parts of Subregion "A" and the northeast, but the sportsman who patronizes northern Maine and New Hampshire is seeking the trout and salmon fishing presently afforded.

35. Since the undeveloped hydroelectric power potential of Subregion "A" far exceeds the estimated demand for many years to come, the power plan has been prepared to serve as an inventory from which certain projects or groups of projects may be selected for development as the needs arise.

36. In view of the fact that the development of new water storage and power projects is expected to occur through the gradual addition of projects at various points in the subregion, it is believed that a careful selection of projects with regard to impact on fish and wildlife, as well as economic feasibility, can be achieved. The alternate proposal for water storage and power development in the Saint John Basin would be far preferable to the inventory plan insofar as fish and wildlife interests are concerned. In the Androscoggin, Kennebec, and Penobscot Basins especially damaging effects on fish and wildlife are indicated if certain projects in the inventory power plan are selected for construction.

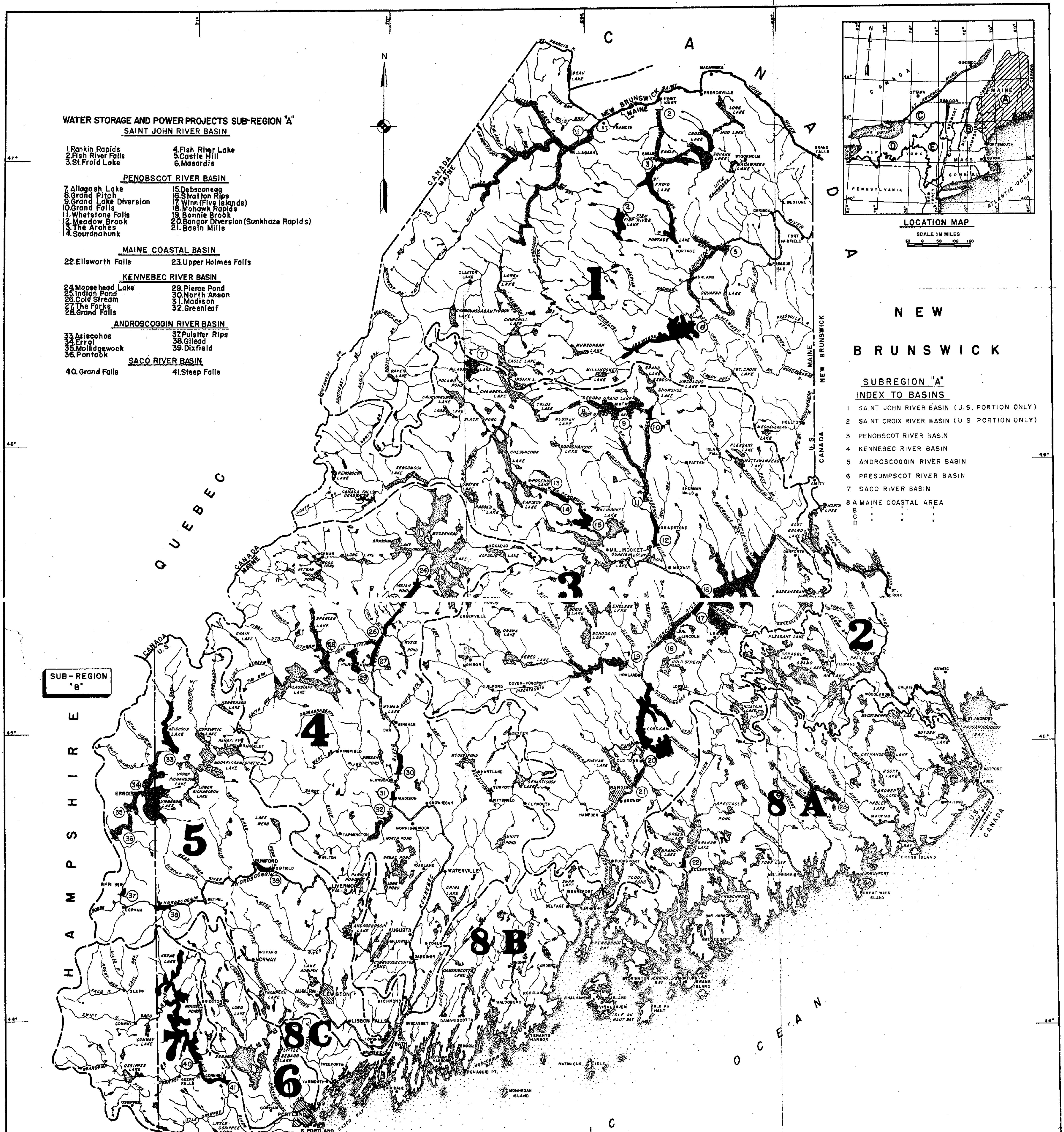

PLATE 7
CHAPTER II

The development of additional capacity of hydroelectric power for utilities by 1975 can be accomplished in the subregion with a minimum of damage to fish and wildlife if construction of those projects most harmful to these resources is held in abeyance. In the event that construction is undertaken at sites where considerable fish and wildlife losses are indicated, provision should be made for fish and wildlife conservation.

37. Maps which indicate the effects on fish and wildlife of water storage and power developments are included in the various Chapters of the report dealing with the larger river basins in Subregion "A". Plate No. 7 of this Chapter illustrates the effects on fish and wildlife of water storage and power development under the inventory power plan for the entire subregion. Included below is a more complete legend to be used in interpreting the effects of water storage and power development on the fish and wildlife resources. This legend may be used when reference is made to either the subregional map or the individual basin maps for the Chapters of the report dealing with the Saint John, Penobscot, Kennebec, and Androscoggin River Basins. Individual basin maps showing effects on fish and wildlife of water storage and power development have not been prepared for the Maine Coastal or Saco River Basins. None of the maps depicting the effects of water storage and power projects on fish and wildlife can be regarded as affording a precise evaluation. Certain groups of projects would be harmful if all were to be constructed, but the construction

of only an individual project from the group might result in slight damages or none at all. Likewise, certain projects would be very harmful from the standpoint of fisheries, but would cause no wildlife damages. The degrees of losses indicated represent judgment decisions as to the total effects on fish and wildlife after considering all factors, including whatever benefits may accrue to fish and wildlife in the post-development period.

Reservoir areas shown in red. - Severe losses to fish and wildlife generally, or severe losses to areas of special importance to either fish or wildlife resources.

Reservoir areas shown in brown. - Significant losses generally, or severe damages to fish or wildlife resources on small areas and areas of less than first-rate importance.

Reservoir areas shown in green. - Only moderate losses to fish and wildlife generally or damages to only one element of fish and wildlife resources of average quality. Also included are projects wherein losses are identified with a reduction in potential, such as diminished feasibility for restoration of anadromous fishes.

Reservoir areas shown in dark blue. - Slight effect insofar as fish and wildlife resources are concerned, or wherein benefits and losses, although considerable, would counterbalance. 1/

38. Plans for pollution abatement, as outlined in the separate basin chapters, would be beneficial to fish and wildlife

interests. Certain features of the agricultural, forestry, and recreational plans for the river basins would likewise be of benefit to fish and wildlife.

FISH AND WILDLIFE PLAN

39. In addition to the suggestion for intensively managing the fish and wildlife resources of the Machias River watershed in Subregion "A", as outlined earlier, the suggestions which follow are generally applicable over the subregion. Many of these features are outlined in greater detail in the several chapters of the report dealing with individual river basins in the subregion. Coordination features of the fish and wildlife plans for the various river basins in the subregion are included only in the chapters devoted to the individual basins. These coordination features are designed to mitigate damages to fish and wildlife, or increase benefits thereto, resulting from the development of other land and water resources.

a. Protection from pollution of waters presently unpolluted and abatement of existing pollution, including shellfish areas.

b. Removal of small dams or inclusion of fishways in dams or other barriers to the migration of desirable fish species.

c. Research and management of fish and wildlife at existing and contemplated water development projects.

d. Application of control techniques to limit abundance and spread of undesirable fish species.

e. Establishment of better and more widespread coordination between the timber operations of owners of large tracts of land and the application of conservation practices for wildlife. Special reference is made to the problem of timber cutting on important deer-wintering areas.

f. Arrangement for public use of existing roads and construction of new roads into the heavily forested areas.

g. Additional forest-fire patrol teams to police the wilderness areas during hunting seasons.

h. Continued research into the problems of the deer resource, with an aggressive program of law enforcement against poaching and predation by dogs.

i. Development of fringe areas around farmlands to retain transitional vegetative cover for small game animals rather than open land or forest.

j. Development of marsh areas for waterfowl and fur bearers, wherever feasible.

k. Installation of a program of anadromous fish restoration with emphasis on research and new methods of financing fishway construction and dam removal operations.

1/ None of the water storage and power projects in Subregion "A" would be strictly beneficial to fish and wildlife resources. With adequate fish and wildlife management, the Sunkhaze Rapids Project would be a benefit to waterfowl, fur bearers and resident fishes, but would result in a reduced potential for Atlantic salmon restoration. The Stratton Rips Project would result in severe wildlife losses, but damages may be appreciably mitigated if wildlife management is conducted about the area following project construction and if water level fluctuations are not excessive.

SECTION X - RECREATION

THE RESOURCES

1. Natural features. - The natural resources in Subregion "A" adaptable to outdoor recreation are so varied and extensive as to make it unusually important in this field. There is a beautiful coastline characterized by numerous bays, inlets and islands, with many good beaches and scenic headlands. There is a vast area of wilderness, dotted with lakes and threaded with an intricate pattern of rivers and streams. Mountain ranges and isolated peaks are found in many parts of the subregion, often in close association with lakes and even in places reaching the sea. Fish and game are abundant, and the opportunities for boating and canoeing are unrivalled. The climate provides pleasantly cool summers and abundant snow for winter sports.

2. The seacoast has a tidal frontage of nearly 2,500 miles. Good beach predominates from Kittery to Cape Elizabeth, with rocky shores and wooded islands providing a varied scene from Casco Bay to the St. Croix River. Harbors for pleasure craft are many and salt water fishing is excellent. The wilderness area is so extensive as to include nearly one-quarter of New England. Within it, or on its borders, are over 2,500 lakes, including many large lakes such as Moosehead, the Rangeley, Belgrade, and Grand Lakes groups, the Fish River Chain, and Sebago. The major rivers, such as the

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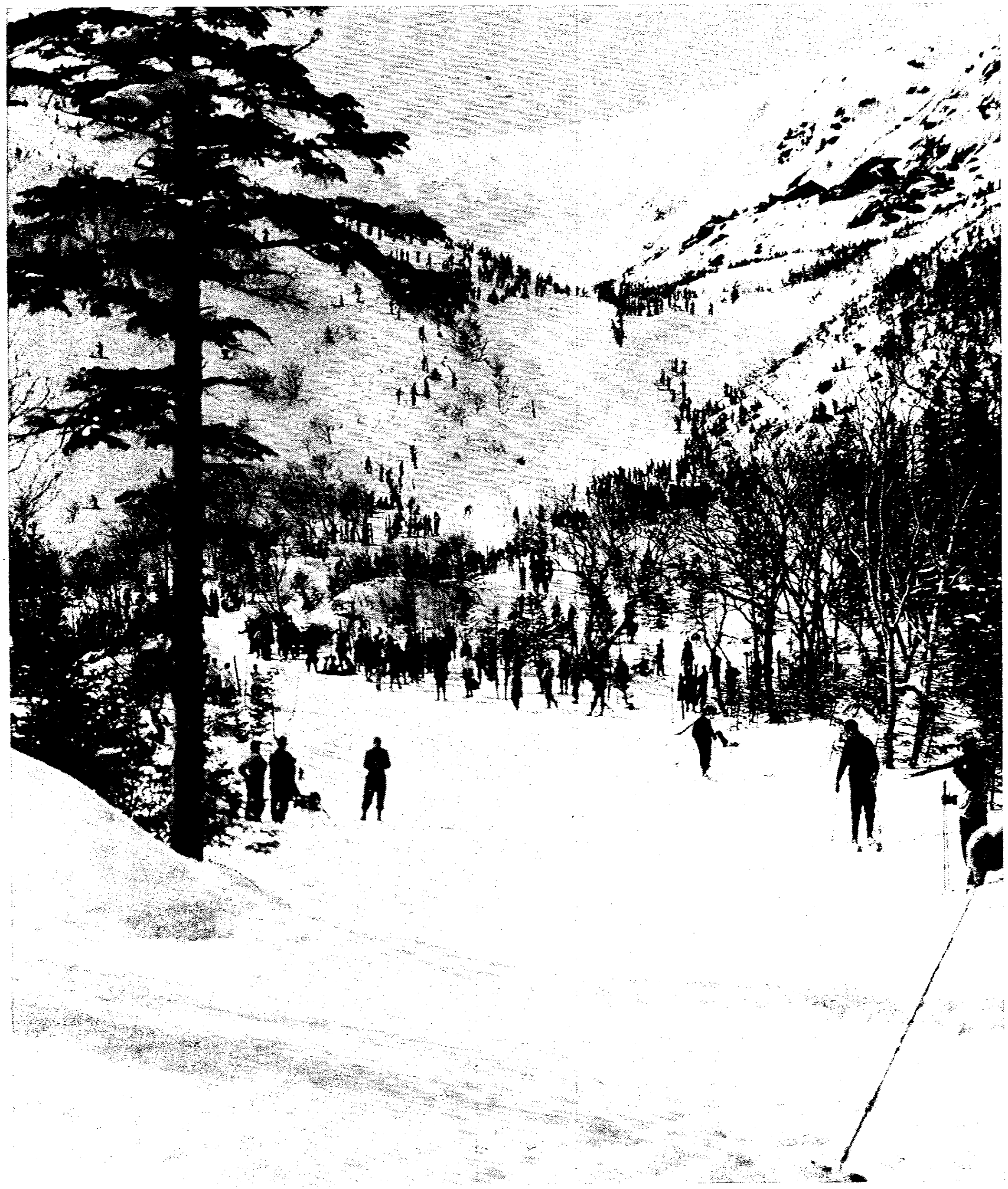
Saint John, the Penobscot, and the Kennebec, reach into the heart of the wilderness area and, with their numerous branches, offer hundreds of miles of excellent white water canoeing. Lakes and streams alike support many varieties of fresh water game fish, and wildlife is abundant. The subregion includes a large part of the White Mountains, the highest range in New England, as well as the Blue Mountains about the Rangeley Lakes and isolated peaks reaching eastward to Moosehead Lake. Mount Katahdin, highest mountain in Maine, is the central feature of the wilderness reservation of Baxter State Park, and Cadillac Mountain, in Acadia National Park, rises directly from the sea.

3. Historical and archeological features. - Many of the once numerous sites associated with the Indian prehistory of the subregion have been obliterated, but there are ancient shellheaps on the coast, including one in Acadia National Park, and prehistoric village sites in the interior, at Sebago Lake State Park on Umbagog Lake, still capable of worthwhile educational development. The many Indian wars and international conflicts that swept the coast and penetrated the interior in Colonial and early National times have left their traces in the form of fortifications covering a long period and illustrating an interesting development in the art of defense. Garrison houses built during the Indian wars still stand in the vicinity of York and Wells, and there are timber and stone remnants of Colonial forts at Augusta, Winslow and Pemmaquid.



Recreational terrain. Ski slopes in the White Mountains.
Subregion "A".

At Castine there is a fine earthwork built and besieged during the American Revolution. There are forts of the War of 1812 at Eastport and North Edgecomb, and massive granite fortifications of the Civil War period in Portland Harbor, at Popham Beach, and elsewhere along the coast. Houses of architectural distinction dating from the prosperous maritime days beginning in the late 18th century are found in many of the towns and cities of the coast and navigable rivers, such as York, Brunswick, Gardiner, Wiscasset, Rockland, Bucksport, and Ellsworth. There are structures associated with distinguished men and women, such as the Wadsworth-Longfellow House in Portland, the Sarah Orne Jewett Memorial in South Berwick, and the reconstructed Montpelier, home of General Henry Knox in Thomaston.

PRESENT USE OF THE RESOURCES FOR RECREATION

4. General recreation. - There are abundant features suitable for most types of outdoor recreation, including camping, picnicking, boating, canoeing, fishing, hunting, hiking, mountain climbing, nature study and winter sports. To the tourist there is offered varied and beautiful scenery, and to the summer-long vacationist a choice of seaside, mountain, lake and wilderness environment. Hunting and fishing, the great traditional outdoor sports, are still basic in the recreational pattern, and skiing has had a phenomenal recent development. Visitor use of the non-urban recreational resources of the subregion is estimated to be about 3,000,000 annually with annual expenditures estimated at $120,000,000.

5. Public recreation development. - There are 30 established public parks and recreational areas in the subregion, with a total attendance in 1952 of 1,599,404. Included in this group are two Federal areas, Acadia National Park with 28,619 acres, and about 330,000 acres of the White Mountain National Forest. There are 11 State parks in Maine, with a total of 177,792 acres, and five State parks in that part of New Hampshire lying within the subregion, with 7,571 acres. Baxter State Park in Maine, with an acreage of 162,930, is the largest single area devoted primarily to public recreation. Acadia National Park has had the largest annual attendance, 551,500 in 1952. The number of visitors in all the more highly developed areas has, however, increased rapidly in recent years. Crawford Notch State Park in New Hampshire, which contains interesting scenic and geological features of the White Mountains, had 300,000 visitors in 1950 and 438,150 two years later. Sebago Lake State Park in Maine, where excellent swimming, picnicking, fishing, boating and camping are available in a readily accessible area, had 95,693 visitors in 1950 and 115,844 in 1952. Even the huge area of Baxter State Park, possessing superb natural features but not yet approachable by a good road, showed a comparable rate of growth in attendance, from 15,000 to 24,409.

6. In addition to its State parks, Maine has 10 memorials, primarily of historical interest but offering limited recreational facilities. Other public recreational areas include 116 roadside

picnic areas along the more heavily travelled highways, and 256 campsites in the less accessible parts of the State. The Appalachian Trail, beginning at Mount Katahdin, offers approximately 300 miles of scenic hiking trail in the subregion.

7. Private recreation development. - Private enterprise has long been active in developing the recreational attractions of the subregion. This development has been most marked along the coast from Kittery to Portland, and in the White Mountains, but is extensive and rapidly increasing on the major lakes, along the remainder of the coast, and elsewhere. Hunting and fishing camps have been a feature of the wilderness country for many years and there are now more than 175 licensed adult recreation camps, chiefly in the more remote forest sections. Approximately 270 organized camps for boys and girls are located chiefly on the lower lakes and along the coast. The long sandy beaches between Kittery and Cape Elizabeth have been intensively developed and have many resort hotels and summer residential colonies. The White Mountains have long had similar facilities but present development is largely along the line of winter sports facilities. There are in the subregion more than 75 golf courses open to vacationists, and on the coast there are numerous harbor facilities for all types of pleasure craft. Along the lakes and streams

of the wilderness country, there are several designated canoe routes traversing hundreds of miles of rivers including the Allagash, the East and West Branches of the Penobscot, and the Machias. Moosehead and Grand Lakes are points of departure for the more important routes.

8. Historic sites preservation. - Seven historic forts, declared surplus by the United States Government, were purchased by the State of Maine in 1924 and are now administered together with the State park system. These old forts are all on the coast, from Kittery Point to Machiasport. To them have been added by purchase or gift a number of other military sites, chiefly on the coast, but including the Fort Kent Blockhouse at Fort Kent, illustrating the border troubles with Canada in 1839-40. These areas, designated as memorials, make up the greater part of the State's historical properties. Their development has been slow, but they have a high educational potential, illustrating as they do wars and rumors of wars from the 17th to the 20th century. Most of them are on scenic coastal points and have considerable general recreation appeal.

9. The Federal Government is planning development as a national historical monument of St. Croix Island, in the St. Croix River, scene of the first French settlement north of Florida in 1604. A few towns and cities hold historical properties, including Fort Western at Augusta, Baxter House at Gorham, and the Old Gaol at York. Most of such preservation of historic sites as has been done

in the subregion is, however, the work of private individuals and agencies. Many fine old houses, some with significant association, are in use as private residences. Historic structures open to the public are chiefly the property of local patriotic and preservation societies. Among the agencies most active in the subregion are the Society for the Preservation of New England Antiquities, State and local chapters of the Daughters of the American Revolution, and the Society for the Preservation of Historic Landmarks in York County, Inc. The Society for the Preservation of New England Antiquities has several fine period houses in Kittery and South Berwick and the York County organization has preserved a number of interesting structures in and near York. The Daughters of the American Revolution some years ago, through local chapters, marked Arnold's Trail, the route of the American army that attacked Quebec in 1775, and maintains historic structures in Skowhegan, Winslow and Machias. The matter of utilization of the resources in connection with recreation and needs is discussed in more detail in Chapter XI, Special Subjects Subregion "A".

RECREATION NEEDS AND POTENTIALITIES

10. General recreation. - The present systems of public recreation areas and facilities in the subregion are inadequate to serve properly the existing needs of the population and will become more obviously insufficient with the growth of population and the steady

increase of tourist visitation. Recreational potential is very great, but is steadily being reduced by varied commercial development at the same time that the need for non-urban recreational facilities is rapidly rising.

11. The most pressing need is for facilities to make fully available the areas already in public ownership. Most of the State parks have not as yet been developed to capacity. State park organizations in both Maine and New Hampshire have active development programs, but lack of funds for such work has made progress slow. There are needed not only more and better physical facilities but also interpretive devices and improved public relations programs.

12. Out-of-State visitation has favored those public areas which are most highly developed, most publicized and most readily accessible from major centers of population. Such areas include Crawford Notch State Park in the White Mountains of New Hampshire, Sebago Lake State Park in southwestern Maine, Acadia National Park, and the recently established Reed State Park, on the coast. A program of full development would distribute this visitation more widely over the subregion. With the current expansion of toll roads both within and to the south and west of the subregion, recreational traffic from other states will inevitably increase greatly. With more of its superb recreational resources adequately developed and publicized, the entire subregion will benefit through increased recreation expenditure.

13. Ultimately the existing areas in public ownership, even when developed to their maximum capacity, will be insufficient to meet recreational needs. An active program for the acquisition of potential recreation sites is needed to meet increased demand, to safeguard outstanding natural resources, and to provide a healthy balance between public and commercial facilities.

14. The need for new public recreational areas is particularly acute along the seacoast, where commercial and private development has very nearly monopolized the available beaches. Less than two miles of good bathing beach on the 2500-mile coastline are now in Federal or State ownership. At least 15 miles of suitable shore frontage should be acquired, preserved and developed for public seashore recreation. Additional public beaches are also needed along inland fresh water lakes. Such areas are needed for day use in the vicinity of major population centers, and additional lake beaches should be sought for future development as recreation and vacation centers along the larger and more remote lakes of the subregion. Particular attention should be given to suitable areas on the Belgrade, Rangeley and Grand Lake groups, the Fish River Chain and Moosehead Lake. In some locations the operation of reservoirs for recreation, insofar as consistent with their primary objectives, would help in meeting their needs.

15. Representative portions of the wilderness for which the subregion is noted should be preserved as far as possible in their

existing condition. A splendid beginning toward this end has been made with the establishment of Baxter State Park, but there are other wilderness areas equally worthy of preservation. Among these are portions of the Allagash River and the Grand Lake vicinity, including superb examples of wilderness river, lake and virgin forest.

16. The existing memorials under State ownership in Maine should be developed to their maximum high potential as educational and inspirational exhibits. Review of the historic sites resources of the State should be made with a view to rounding out the system, now almost exclusively military in character, with sites illustrating other significant aspects of local history. The splendid work of private and local groups now preserving and presenting to the public many historic structures should be encouraged.

17. Estimate of future use. - The recreation plans as outlined in Section X, Chapters III to IX inclusive, are offered as a guide for the development of the resources for recreational purposes. They are designed to provide for the protection of significant scenic, scientific, historic and prehistoric features. They also provide for the expansion and in some instances redevelopment of existing non-urban public recreational areas and facilities and for the development of additional areas utilizing outstanding land and water features. A summary of costs for recreational developments is given in Table 41a.

18. The plans, if carried out, would permit greater opportunities for public use of the seacoast, the inland lakes, the mountains, the

wilderness areas and the many historic features in connection with both active and passive forms of recreation. It is conservatively estimated that development of the natural resources of the subregion for non-urban recreational use would result in a visitation of approximately 5,143,000 annually. Total expenditures in connection with this form of recreation could be expected to reach $170,850,000 annually.

Table 41a - Summary of estimated costs for recreational developments, Subregion "A"

Basin or area	First cost	Annual charges
Saint John	$ 5,970,000	$ 427,900
St. Croix	1,309,550	96,430
Penobscot	4,055,000	321,430
Kennebec	5,729,500	410,300
Androscoggin	3,623,000	548,360
Presumpscot	861,500	74,550
Saco	1,598,000	134,560
Maine Coastal	12,565,000	1,073,000
Total	$35,711,550	$3,086,530

SECTION XI - LAND MANAGEMENT

1. The soil and forest resources of Subregion "A," are an important phase in the economy of the area. The management of these important resources in such a way that they may contribute an even larger amount to the economy without damage to the resource is the purpose of land management measures contained in the various river basin chapters.

2. Growing season. - The climate of the subregion is characterized by long cold winters with relatively cool summers. The coastal area is influenced by the ocean, having from 160 to 180 frost-free days, while in the northern part of the Subregion there is an average of 100 frost-free days per year. The rainfall varies from 35 to 50 inches with a considerable variation between river basins. The Penobscot basin has an average of 40 to 50 inches compared with 36 to 42 inches in the Saint John. Generally speaking, the rainfall is fairly well distributed throughout the growing season. Droughty conditions, however, do occur in all basins especially during the months of July and August. The temperature ranges and rainfall are generally conducive to the growing of grass.

3. Soils. - There is a wide variation in the soils ranging from the heavier soils in the southern and coastal portions of the Subregion to the light gravelly soils of the Androscoggin and Kennebec River Basins and the loam and gravelly loam soils represented by the Caribou, Easton and Mapleton series in the Saint John valley. These

last-mentioned soils comprise the most important ones for the growing of potatoes in Aroostook County.

4. Land management areas. - Approximately two-thirds of the subregion is located in the Maine Woods area, consisting of glaciated non-calcareous crystalline gneiss and metamorphic rocks. The upland soils are well drained, but large swamps occupy the depressions. In the crystalline rock country, the soils are stony. In the forested area, there is little information available concerning the soils. The Maine Woods area is predominantly non-agricultural with about two percent of the acreage in farms. There are a few farms in the Maine portion, and in New Hampshire, less than ten percent of the area is in farms. Farms are found chiefly along the stream valleys. Dairying and some potato production constitute about the only types of agriculture. The major conservation problem is the management and protection of forests. On crop and pastureland, land use adjustments, pasture clearing, management and drainage are the usual problems.

5. The Aroostook area consists of the eastern cultivated portion of Aroostook County with slightly more than 1,750,000 acres, of which 750,000 acres are in farms. It is a region of rather uniformly undulating to rolling land with a general elevation of 600 to 700 feet. The northern part adjacent to the Saint John River is more strongly rolling or hilly and elevations run about 200 feet higher. Occasional hills and ridges in the central portion rise to more than double the average elevation. Mars Hill, the highest, is 1,695 feet above sea

Intensive land use in potato area of Aroostook County, Maine. Subregion "A".

Potato harvest in Aroostook County, Maine. Subregion "A".

level. The average annual precipitation is about 34 inches distributed rather uniformly throughout the year. The winters are long and cold with 80 to 100 inches of snow. The summers are short and cool with half the annual precipitation occurring in the spring and summer months. The geologic formations of limestone, calcareous and acid shales are overlain by thin mantle of glacial till consisting mostly of these materials. In sections where limestone and calcareous shale influence the till, Caribou, Perham and associated soils are found. Where the till is composed mainly of acid shale, the well drained soil is Plaisted. Loams and gravelly loams which are usually friable and easily worked predominate. Most of the land used for farming is well drained. Extensive acreages of wet land occur either as uniform large areas or in smaller patchy areas intermittent with better drained land. The relief varies from gently undulating to rolling with depressions where the wet soils occur. Occasional hills and ridges of intrusive rock rise above the general level of the land in various parts of the area. Agriculture is based on a potato economy, with hay and oats as secondary crops.

6. The Bangor Upland area, comprising approximately 3,500,000 acres in central Maine, is a plain of broadly rolling hills at a general elevation of 500 to 600 feet above sea level. Slightly over 2,000,000 acres are in farms. The average annual precipitation ranges from 35 to 40 inches. There are frequently times when the rainfall is not well distributed and crops suffer from short droughts. The soils are formed

in glacial deposits which came largely from local slates, shales and schist. The soils are medium textured and are more productive than the granitic soils in areas to the south and west, since many of the rocks contain some lime. Dairying and general farming, including the production of sweet corn and other canning crops, are the principal farming activities. There is also a considerable acreage of potatoes.

7. The Northern New England Upland Area is similar in many respects to the adjacent Bangor Uplands but is somewhat higher, has lower average temperatures and higher rainfall. Soils are usually loose, open and bouldery. About 50 percent of this area in Maine and New Hampshire is in farms. Agriculture is confined largely to the fertile valley floors and to the rolling ridgetops. Dairying is the dominant type of agriculture.

8. The remainder of the subregion is a northern extension of the Seaboard Lowland Area. General elevations are from 100 to 200 feet above sea level and there are few places higher than 500 feet. The climate is cool but extreme temperatures are moderated by the influence of the ocean. Rainfall tends to be higher than in the upland areas. South of Portland, soils have developed in glacial outwash, till and marine deposits. North and East of Portland water-laid deposits are less common. Parent materials for the gravel and marine deposits are non-calcareous crystalline rocks. These soils are moderately light textured and generally open and well drained. Stony soils are common. About 40 percent of the area is in farms. Dairying is the principal

agricultural activity, although truck gardening and poultry raising are becoming increasingly important. Conservation problems include fertility maintenance on sandy soils, supplemental irrigation and, in places, artificial drainage.

9. Forests. - Eighty-five percent of the land area in the subregion is in forests. The headwaters of all river basins are heavily forested, the land being owned in large blocks by a few companies. Most of the lands have been cut over at least once. The predominant species in the headwaters of the river basins are spruce and fir, with hardwood along the ridges. Pine is the predominant softwood in the central and southern parts of the area.

10. Size and types of farms. - There are approximately 30,545 farms in the area varying in average size from 114 acres to 181 acres. Dairy products and poultry are the most important sources of income except in the Saint John Basin where the most important source is potatoes. Income from the farm woodland is important in all basins except the Saint John.

11. Ownership of farms. - Practically 90% of all farms in the area are owner-operated. Many farms adjacent to the Saint John River commonly have a few rods of frontage along the river and extend at right angle to the river for distances up to two miles. Efficient management of such farms is practically impossible. Some improvement is being made through leasing arrangements to permit operation of large blocks of land under one management.

12. Problems retarding development. - The maintenance of fertility is one of the important problems to be solved in bringing the soils to maximum production. There are many thousands of acres of light gravelly soil which have been abandoned for farm use and will probably permanently revert to forest. This makes it all the more important to operate efficiently the soils being farmed.

13. In the Kennebec and Penobscot River Basins and in the coastal area there are several large areas of wetland needing drainage.

14. Erosion is a problem on slopes that are used for cultivated crops. This is especially severe in the Saint John Valley in Aroostook County where potatoes are grown on sloping land.

15. A lack of uniform rainfall during the growing months has prompted an interest in supplemental irrigation especially of cultivated crops such as potatoes, vegetables and small fruits.

16. In the Kennebec River Basin especially, and to some extent in others, farmers have indicated a lack of sufficient water for livestock.

17. Overgrazing of farm woodlots and lack of management have reduced the production of forest products.

18. Lack of roads in the forest lands is a problem affecting the harvest and the management of the remaining growing stock. The toll taken by fire, disease, and insects is an important item.

19. Suggested land treatment program. - The profitable production of food and fiber to meet market demands without injury to the soil

and forest resources, and often improving fish and wildlife habitat and enhancing recreational values, is the purpose of the land treatment program.

20. In the various river basins, especially the Saint John, the protection of the soil from destructive erosion is one of the important objectives. Strip cropping of cultivated land is one of the principal protective practices. Terraces, diversions and cover crops are also used to control erosion. The use of lime and fertilizer to maintain fertility and increase production of forage is suggested for all river basins especially the Penobscot, Kennebec, and Androscoggin where dairy farming is of greatest importance. In the Saint John River Basin large amounts of fertilizer are used to grow potatoes. Excellent crops of legumes, which are used as green manure crops are produced, in the rotation following potatoes. The conservation of moisture and management of water are achieved by several practices such as mulching, strip cropping, drainage, and farm ponds. The construction of farm ponds is especially important in the coastal area where farmers need water for livestock and as a means of irrigation.

21. Provision is made for education, technical services, and research in order that farmers may have the latest information concerning new practices that will make their efforts more productive.

22. The number of farmers electing to participate in the program will be directly affected by the information which they have of the various practices and the technical assistance provided in carrying them out on individual farms.

23. The construction of forest roads, both primary and secondary, is needed throughout the subregion especially in the wild land areas to facilitate management of the forest land. Companies owning large acreages of forest land have built and are continuing to build many miles of all-year roads which will step up the production potential of this forest land. Adequate protection of forests from fire involves the construction of fire towers and installation of radio equipment. The small amount of money provided in each river basin for detection of insect pests and diseases does not cover the cost of control. It is provided in order that early detection of damage by insects and diseases is possible and proper control measures may be instituted. Timber stand improvement on forest land and farm woodlots is one of the most expensive measures in the forestry program, and yet the return from this measure is expected to be high.

24. Certain items not susceptible of quantitative analysis or tabular presentation constitute essential features of a well rounded forestry program. These include forest taxation, credits, insurance, and management, the latter particularly, with respect to methods used in harvesting timber. The general principles involved are similar throughout the New England-New York area and are discussed further in Chapter XXXIX. Certain features characteristic of Subregion "A" are, however, discussed here.

25. Methods of taxing timber and forest land have important effects upon forest practice. Much thought has been given to the development of tax methods which would, in effect, constitute inducement for better practice. Both States have given practical consideration to this subject. New Hampshire has a tax law which is directly related to cutting practice. It provides a lower tax rate for owners who meet certain conditions prescribed by the law. In Maine, legislation of recent origin provides for appeals by the owner should taxes on his forest property appear to encourage destructive forms of cutting.

26. Credit in relation to forest conservation is another item which has been given much study. Generally speaking, short term loans are available for use in liquidating forest resources. On the other hand, long term loans needed for forest perpetuation or improvement are difficult or impossible to secure.

27. A third item of importance is forest fire insurance. Effective forest fire organizations and services have been developed in New Hampshire and Maine and, as a result, forest fire losses in most years are very low throughout the two-state area. Occasionally, however, disastrous fires occur and result in severe losses. In most cases the owner or owners affected are in no way responsible for the fires but cannot in all cases be protected against such losses because suitable insurance cannot always be had at attractive rates.

28. Methods of cutting used in harvesting forest products constitute a most important item in determining whether or not a given tract of forest land will be maintained in productive condition. In recent years, a number of public and private agencies have studied timber cutting practices in use. Their findings differ in detail but agree that a substantial proportion of timber cutting is not as good as it could be or should be with respect to effect upon productivity.

29. State agencies concerned with programs to develop the soil and water resources. - For many years the land grant colleges including Extension Services and the Experiment Stations located at the Universities of Maine and New Hampshire have been important factors in providing information to farm people concerning the care and management of their farm land. The Maine College of Forestry, the Maine and New Hampshire Forest Services, the Penobscot Experimental Forest and the White Mountain National Forest have made definite contributions to the management of forest lands.

30. The soil conservation districts and local committees of the Production and Marketing Administration assist farmers with their soil and forest conservation practices.

31. The Maine Department of Agriculture is concerned with regulatory work of importance to agriculture as well as cooperating with the above-named agencies to promote agricultural development.

32. The United States Department of Agriculture through its various bureaus has established good relationships with the state agencies named to assist them in any way possible in making information and services available to the farmers and forest land owners. This assistance is not only for the production of agricultural commodities but also to protect and improve the soil and forest resource.

LAND MANAGEMENT PLAN

33. The land management plan for Subregion "A" is as follows:

a. Land use adjustments: changing land from present uses to other and better uses.

b. Capital improvements to crop and pasture land: including erosion control, land clearing, fencing, seeding to premanent pasture, drainage and farm ponds.

c. Periodic practices for crop and pasture land: including fertilizing hay, pasture and cultivated crops.

d. Forestry measures: including tree planting, timber stand improvement, forest development roads, other measures.

e. Facilitating measures for crop and pasture land and for forest land: including educational assistance, technical services, resource surveys and plans, line surveys and maps, aerial photographs and maps, and acquisition of land for forestry purposes.

34. <u>Costs</u>. - Estimated installation and annual costs for land management measures are given, by basin or area, in Table 42.

Table 42 - Summary of installation and annual costs for land management measures, Subregion "A"

Basin or area	Installation cost	Annual cost
Saint John	$12,037,100	$ 2,177,300
St. Croix	1/	
Penobscot	11,266,000	1,952,200
Kennebec	11,868,200	2,593,000
Androscoggin	8,799,400	1,344,900
Presumpscot	1/	
Saco	1/	
Maine Coastal	14,532,200	2,556,800
Total for Subregion	$58,502,900	$10,624,200

1/ Included in cost for Maine Coastal.

35. Benefits. - The plan would provide measures to meet expanding needs for food and fiber; provide for the conservation and improvement of soil and forest resources; and for the conservation of water and the reduction of peak run-off. The major benefits from conserving and improving crop and pasture lands are susceptible of monetary evaluation. Increased crop and forage production, reduction of soil erosion and of flood water damage would amount to annual benefits of $9,274,400. These measures would cost annually about $8,304,400, showing a benefit-cost ratio of 1.12 to 1. Benefits not evaluated in monetary terms are sediment control, fire

protection, water supply for irrigation and spraying from farm pond development, and the enhancement of wildlife values.

36. Tree planting, timber stand improvement, development of forest roads and other measures on forest land would cost annually about $2,319,800. The annual benefits from these measures would amount to about $3,874,113, giving a benefit-cost ratio of 1.67 to 1.

SECTION XII - MINERALS

INTRODUCTION

1. This section presents a general view of the present mineral industry of Subregion "A" and evaluates the mineral resources as now known. Mineral deposits are described in detail, and problems of their development and use are discussed at length in the Chapters on individual river basins. References to literature on minerals will be found in the river basin chapters and in the commodity studies covering the entire New England-New York Region (Chapter XXXIX, Special Subjects, Regional).

MINERAL INDUSTRY

2. Although the mineral industry of the subregion occupies only a minor position in the production picture of the United States, accounting for about one-half of 1 percent of the total value of the mineral production of the country, it has been in existence for many years. It is probable that the early settlers of the region used several of the mineral materials for assistance in their early difficulties of living. For instance, they probably used the local clays and stone as some of their early building materials.

3. Reports of the early discovery of industrial minerals are on record. For example, C.T. Jackson (1838) records the presence of "lime burners" in 1937 as well as the discovery of "magnetic iron" at Mt.

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Desert and iron and manganese near Houlton, and mentions the Lubec Mines, an early lead-zinc prospect.

4. C. H. Hitchcock (1862) in 1861 reports production of limestone and granite at that time as well as the discovery of tungsten. Feldspar was produced as early as 1860 to replace the importation of Cornish stone from England, and iron from the Katahdin deposit was produced as early as 1848, copper as early as 1878, and lead and zinc in 1881.

5. Most of these early enterprises lasted only a few years and many of them have little prospect of again entering the commercial field. Production figures on these early operations are either nonexistent or of uncertain accuracy, but it is certain that the output was small and irregular. For the past several years the Bureau of Mines in its annual volumes of the Minerals Yearbook has reported the production and value of the mineral output. Some of the more sporadic productions are grouped into a miscellaneous figure.

6. Since 1945, the end of World War II, these Bureau of Mines reports have shown average annual production for Maine as listed in Table 43.

Table 43 - Production and value of the mineral output, Subregion "A" 1/

			Value 1950
Cement	1,079,000	bbls. (1947 through 1950 only)	$ 2,705,000
Clays	27,500	short tons (with 1945 figures omitting clay used in cement and heavy clay products)	26,000
Feldspar	16,890	long tons	125,000
Mica			
scrap	---		1,000
sheet	---		3/
Peat	2,355	short tons (since 1947 only)	62,000
Sand and gravel	3,600,000	short tons (omitting ~~1938~~ 1947 as only "commercial" production was included for that year)	1,726,000
Stone	218,000	short tons (slate, granite, etc.)	2,214,000
Undistributed 2/			602,000

1/ The quantities and values for the New Hampshire portion of the subregion cannot be identified, but would be relatively small.

2/ Undistributed: Beryllium concentrate, gem stones, lime, lithium minerals (1948 and 1950), quartz from pegmatites and quartzite (1950), sand and gravel (noncommercial, 1948), slate, stone (unclassified, 1947; and crushed sandstone, 1950, and minerals whose value must be concealed for particular years.

3/ Not available separately.

7. During this same period an average of 28.4 short tons of scrap mica was produced per year with an additional irregular but small production of sheet mica.

8. Present operations. - Present operations in connection with the production of mineral raw materials in Subregion "A" are mainly concerned with low value nonmetallic materials such as sand and gravel, stone, clay, and limestone. Pegmatite minerals are being produced, but no mineral production for the recovery of metals is now being made.

9. In 1953 about 80 percent of the annual production valued at five to eight million dollars came from nonmetallic mineral products such as cement, stone, and sand and gravel. As of January 1, 1953, the following mineral producing companies were in operation in Subregion "A".

Stone

Basalt - One company is producing crushed rock for concrete and road metal use.

Granite - One company in New Hampshire is producing crushed and dimension stone; two producing crushed stone, one producing both crushed and dimension stone, and six producing only dimension stone.

Limestone - One cement plant, one company manufacturing burned lime, and one company producing crushed rock.

Sand and gravel

Forty-nine known producers are operating in thirteen Maine counties and two counties in New Hampshire.

Contractors and government agencies account for 90 percent of the production, and 94 percent of the subregion's output is used in road construction and 5 percent in the building trades.

Slate

Two companies are producing slate.

Clay

Many small brick plants are operating in various sections of the subregion using local sources of raw materials and supplying local demands.

Peat

Three companies are producing peat, practically all of which is used for agricultural purposes.

Pegmatite minerals

Feldspar is at present the main pegmatite mineral of commercial importance. Occasionally small amounts of beryl are produced as a by-product of feldspar mining. Some low-grade scrap mica is produced with an accompanying small quantity of sheet mica.

10. Mining and quarrying with few exceptions have been and are centered in the western and coastal sections of Maine. Exceptions are the quarries in the Monson-Brownville slate belt, the long abandoned Katahdin iron works, and quarrying and small scale mining in the Houlton-Caribou area. Clay, sand and gravel, peat and small stone quarrying operations are found wherever demands, many of them local, have warranted.

11. Except for the northwestern part of the State, no point in Maine is more than 40 miles from a railroad, and the distances to roads and the sea coast are generally much less.

GENERAL GEOLOGY

12. Topographic quadrangle maps are lacking in parts of north central and central Maine, and detailed geologic maps, necessary for effective exploration prospecting, are available for only a few small areas in the subregion. Keith's Preliminary Geologic Map of Maine (1933) was compiled principally from reconnaissance studies made during the past century. The bedrock geology of several quadrangles was mapped prior to 1914 and special areas, generally in the vicinity of known mineral deposits, have been investigated by the U. S. Geological Survey. A few quadrangles and special areas have been mapped by the Maine Geological Survey and special mineral investigations have been made recently by the U. S. Bureau of Mines. Currently (1953-54), quadrangle mapping by the U. S. Geological Survey, the State Geological Survey and by geologists from colleges and universities is in progress.

13. Geologic investigations by the U. S. Geological Survey are in progress on the manganese deposits of eastern Aroostook County. The U. S. Bureau of Mines has completed trenching, sampling, and diamond drilling of some of these deposits and is now investigating beneficiation methods which would permit economic recovery of Aroostook County's manganese and iron. Many pegmatite mines and prospects have been mapped by the U. S. Geological Survey and the Maine Geological Survey; two have been

diamond drilled by the U. S. Bureau of Mines. Pegmatite deposits have been prospected systematically only in a few small areas. Three of the old copper and zinc mines in southeastern Maine have been diamond drilled by the U. S. Bureau of Mines and by private companies, but the surface geology of only one mine has been mapped to aid in correlation problems. The most promising asbestos prospects have been investigated. One has been diamond drilled and additional drilling is now in progress (1954).

14. Most of Subregion "A" is covered by unconsolidated surficial deposits of sand, gravel, clay, and alluvium. In general, these deposits are thicker and more continuous in the valley bottoms and lowlands than on hill slopes and uplands. Bedrock is best exposed along the coast, in stream beds, and in upland areas.

15. Surficial geology. - The surficial materials in Subregion "A" include deposits left by a continental glacier that covered New England in the recent geologic past, deposits resulting from marine inundation as the glacier retreated, and recent deposits such as river alluvium and accumulations in swamps, bogs, and lakes.

16. Materials formed by glacial processes are the most extensive and widespread. Till, a heterogeneous mixture of silt, sand, gravel, cobbles, and boulders, deposited directly by the

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ice, covers most of the valley walls and upland areas, and caps some of the lower mountains. It commonly occurs in drumlins (oval hills) in southwestern and northeastern Maine. Water-worked materials deposited by glacial melt water, and collectively called outwash, occurs mainly in the lower parts of valleys and in the lowlands of the region. The outwash deposits consist chiefly of stratified sand and gravel and form topographic features known as outwash plains, terraces, kames, and eskers. The outwash plains are prominent in the broad, open valleys and in low coastal areas where the deposits overlie till as well as bedrock. Eskers (long, sinuous ridges of sand and gravel) are most conspicuous in southeastern and eastern Maine. Kames (rounded hills composed of sand and gravel) and terraces are local features.

17. Marine clays, deposited during the retreat of the glacier, in general overlie the till and outwash deposits. In some places, however, they are interbedded with glacial sands and gravels and in others they are covered by outwash. Clay deposits thicken seaward from an irregular inland margin that extends farther north between the Kennebec and Penobscot Rivers than elsewhere in the subregion.

18. Bedrock geology. - Because of the masking effect of the surficial materials and lack of detailed geologic mapping, only

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the broader features of the bedrock geology of the region are known even moderately well. The northern and central parts of Maine, approximately 70 percent of the state, and northern New Hampshire are underlain by slighly altered sedimentary rocks with some interlayed volcanic rocks. The bedded rocks consist mostly of slate and argillite, quartzite, and limestone. These rocks have been compressed into a series of folds, and erosion has exposed the edges of the beds in belts trending northeasterly. Igneous intrusions, mostly granitic in composition, cut the folded rocks in many places, especially in the vicinity of Mt. Katahdin and in the area between the Penobscot River and the International Boundary.

19. In most of the southern one-third of the region, the rocks are similar in original composition to those farther north, but have been much more intensely altered. The axes of folding trend more northerly in the southwestern part of the region, and all of the folding is much more severe. Intrusive rocks are much more abundant in the southern area, and are related to the high degree of metamorphism. Granite is widespread, in large and small masses, and there are many small bodies of pegmatite, gabbro, and diabase. Although small faults have been found wherever detailed geologic work has been done, the major deformation is believed to have been by folding rather than faulting.

20. In evaluating the mineral potentialities of the region, it is important to point out that geologically the subregion is very similar to and continuous with New Brunswick and the Eastern Townships of Quebec. By aggressive exploration in these Provinces of Canada many important mineral deposits have been discovered recently and are being developed rapidly by the Canadians. The minerals include copper, lead, zinc, nickel, and tungsten, to mention a few.

MINERAL COMMODITIES

21. Abrasives. - Although about 500 tons of felsite and basalt pebbles suitable for grinding media were obtained during World War II from beaches in Washington and Hancock Counties, Maine, there are no important deposits of high-grade abrasive materials in this subregion.

22. Asbestos. - A belt of serpentine in the Jim Pond and Little Spencer Stream areas of Franklin and Somerset Counties, Maine, contains veinlets of chrysotile asbestos. The asbestos deposits on Little Spencer Stream were drilled during the summer of 1954. The results were encouraging.

23. In the Little Spencer Stream area below Spencer Lake, 11 drill holes were put down along a zone some 9,000 feet of length. Eight of the drill holes cut asbestos-bearing rock ranging in content from three to eight percent. All of the eight bottomed in ore. The asbestos was good quality, short fibre material. Further investigation is warranted.

Table 44. Distribution of mineral commodities in river basins, Subregion "A"

Mineral commodity	SAINT JOHN	ST. CROIX	PENOBSCOT	KENNEBEC	ANDROSCOGGIN	PRESUMPSCOT	SACO	MAINE COASTAL
Abrasives								X
Asbestos				X				X
Clay			X	X	X	X	X	X
Copper, zinc, and lead				X	X			X
Diatomite					X		X	X
Granite	X	X	X	X	X	X	X	X
Graphite				X	X			
Iron	X						X	
Limestone and dolomite	X		X	X				X
Manganese	X							X
Molybdenite	X							X
Peat	X	X	X	X	X	X	X	X
Pegmatite minerals					X	X	X	X
Pyrites			X	X	X			X
Refractory minerals					X	X		X
Sand and gravel	X	X	X	X	X	X	X	X
Serpentine								X
Slate			X					
Miscellaneous metals*	X				X		X	

* Gold, silver, antimony, tin, tungsten

24. Clay. - The principal potential sources of clay are in the glacial and post-glacial marine clays that occur along the coast and in the lower parts of the larger river valleys in Maine. The clays are thickest in the southwestern part of the state. Because of iron oxide and carbonaceous matter as impurities, the present use of the clay is limited to brick and tile. If economic methods of beneficiation can be worked out, the clays may become an important source of filler for the paper industry.

25. Copper, lead, and zinc. - Deposits of copper, lead, and zinc have been prospected and mined in a mineralized belt between Penobscot Bay and Eastport. The Douglas mine at Blue Hill, Maine is said to have produced more than two million pounds of copper, and the Cape Rosier mine shipped about 10,000 tons of ore between 1881 and 1883. Lead and zinc have been mined in Somerset County, Maine and Coos and Carroll Counties, New Hampshire. Other than the deposit at Cape Rosier in southern Hancock County, Maine, which probably merits further investigation, none of the occurrences appear to be of economic significance.

26. The discovery of major deposits of copper, lead, and zinc in New Brunswick along the regional trend of geologic structures in Maine, and in similar rocks, emphasizes the need

for more geologic investigation in the region. Although the known deposits may not be very significant, it seems quite probable that worthwhile deposits are concealed under glacial debris. A systematic program of geologic mapping, and geochemical and geophysical surveys is indicated, therefore, for the subregion.

27. Diatomite. - There are many deposits of diatomite in swamps and peat bogs. Some diatomite has been produced from Washington County, and Franklin County in Maine and Carroll County, New Hampshire, but most of the deposits are too small and too low grade to be worked profitably.

28. Granite. - The subregion contains large quantities of granite and related rocks suitable for the production of dimension stone and crushed stone. The term granite, as used in the stone industry, includes many different types of igneous rocks ranging in composition from true granite to gabbro. Commercial granite has been quarried at many places in Aroostook, Waldo, Penobscot, Franklin, Washington, Knox, Hancock, and York Counties, Maine and in Carroll and Coos Counties, New Hampshire.

29. Graphite. - Small deposits of disseminated graphite have been found in or adjacent to igneous bodies at several places in Oxford, Franklin, Cumberland, and Sagadahoc Counties, Maine.

30. Although some of these occurrences have been prospected, no commercial deposits have been discovered. It is unlikely that further exploration will uncover minable quantities of graphite.

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31. Iron. - Most of the iron ore produced in the subregion came from a residual deposit of limonite and hematite on the large pyrrhotite deposit in Piscataquis County, Maine. The limonite and hematite occur as a gossan formed by weathering of the pyrrhotite body. Two small deposits of magnetite have been found at Bartlett and Jackson, New Hampshire.

32. None of these deposits is of present economic value and the probability of finding larger deposits of iron ores in the subregion is not believed to be encouraging. (See also Manganese).

33. Limestone and dolomite. - The carbonate rocks in Subregion "A" range from relatively pure dolomite and pure high-calcium limestone to impure shaly limestone. The most important and productive deposits occur in a belt extending 5 miles northeastward from Thomaston, Knox County, Maine. At present the chief products from this limestone belt are cement, agricultural lime, fluxing stone, and high-calcium stone for chemical use. The reserves are very large and should support the present industry for many years. Probably the largest reserves of relatively pure dolomite are those in the Warren district. Widespread deposits of impure limestone in Aroostook County have been worked locally for road metal and agricultural lime.

34. Manganese. - Deposits of low-grade manganiferous iron ore occur in three districts in eastern Aroostook County, Maine.

The northern district, west of Presque Isle and Caribou, contains about 20 known deposits. The southern district in the Houlton area contains scattered deposits of manganiferous iron ore that are smaller than those in the northern district. The largest known deposit in the subregion is the Maple Mountain-Hovey Mountain deposit, 21 miles northwesterly from Houlton.

35. The size of the manganiferous iron ore deposits is fairly well known from geologic studies of many small areas and a recent extensive program of exploration by the U. S. Bureau of Mines, including diamond drilling. The ore reserves in the Maple Mountain-Hovey Mountain deposit have been estimated as 256,000,000 tons of material that averages 8.9 percent manganese and 20.7 percent iron. The largest deposit in the northern district at Castle Hill has been explored sufficiently to a depth of 200 feet to indicate reserves of about 26,000,000 long tons of material averaging 10.4 percent manganese. Estimates of reserves of other large deposits in the northern and southern districts are given by Miller (1947). Although the deposits present difficult problems in mining and beneficiation, which have not been solved, they represent one of the largest potential sources of manganese in this country.

36. Molybdenite. - Small deposits of molybdenite have been found in Aroostook County and in two bodies of granite or granitic pegmatite near Tunk Pond, Hancock County and in the town of Cooper,

Washington County, Maine. The molybdenite in the deposits is so distributed that large tonnages of rock would have to be handled to recover the ore. It is not known whether commercial quantities are available because the deposits have not been explored at depth.

37. Peat. - Most of the peat deposits occur in bogs and swamps in coastal areas and along the larger river valleys. The highest grade deposits so far reported occur in a narrow belt along the coast of Maine, particularly in Hancock and Washington Counties.

38. The peat reserves of Maine are very large and have been conservatively estimated at 150,000,000 tons (presumably air-dried weight, although the author does not say). The available information on the peat reserves in the New Hampshire part of the subregion indicates much smaller tonnages of peat.

39. Pegmatite minerals. - Feldspar, quartz, mica (scrap and sheet), beryl, columbite-tantalite, spodumene, lepidolite, and pollucite have been produced in three principal districts in Maine; the Sagadahoc County, the Auburn-Paris and Rumford-Newry districts in Oxford County; and in Carroll County, New Hampshire.

40. Data on reserves of pegmatite minerals are lacking but tonnages of feldspar and quartz are believed to be large. Reserves of the other pegmatite minerals are small.

41. Pyrites. - The only large deposit of pyrites in the subregion is near the Katahdin Iron Works in the southern part of Piscataquis County, Maine. Incomplete exploration by drilling indicates that the reserves for each 100 feet of depth of the deposit are about 9,000,000 tons containing about 4,100,000 tons of iron and about 2,500,000 tons of sulfur. Pyrrhotite and pyrite have been found at several other places in the subregion. It seems probable that deposits of potential value concealed under glacial material will be found by modern geophysical and geochemical methods.

42. Refractory minerals. - Many of the metamorphosed sedimentary rocks in the southern part of the subregion contain andalusite, kyanite, or sillimanite. Although no data are available on size and grade of deposits, the nature of the occurrences in Cumberland and Knox Counties, Maine, is such that they are worthy of further investigation.

43. Sand and gravel. - The sand and gravel deposits are mainly in large outwash plains, especially in coastal areas of the region. Deposits of superior quality, however, are in eskers, which are most common in southeastern and eastern Maine. In the southern part of the state the deposits are composed chiefly of materials derived from granitic rocks and metamorphosed sedimentary rocks of this area, and are superior

in quality to the deposits in the northern part of the subregion. Outwash terraces and kames also are potential sources of sand and gravel, and in some areas these are the best local sources. Sand and gravel deposits of Maine are sufficient for the expectable needs in most of the subregion.

44. Serpentine. - A large body of serpentine extends across the northern part of Deer Isle. It was once quarried and sawed into small blocks for building purposes. This rock might be used as a source of fertilizer raw material for the magnesia-deficient soils in Aroostook County.

45. Slate. - Reserves of commercial slate are very large, the deposits extending northeasterly through the central part of Maine from Blanchard to Brownville, Piscataquis County. Underground quarries in the Monson district have been active for many years and are the principal domestic source of electrical slate for switchboards and similar purposes.

46. Miscellaneous metals. - Gold, silver, antimony, tin, and tungsten have been found at several widely scattered places in the subregion. Gold occurs in minor quantities in some of the stream deposits in northwestern Maine (northern Oxford County). Silver is associated with lead in veins at Madison, New Hampshire. The known occurrences of antimony, tin, and tungsten are in small veins that cut various rock types: antimony occurs near Houlton, Maine, tin near Winslow,

Maine, and Jackson, New Hampshire. Tungsten has been found as wolframite at Blue Hill, Hancock County and near Bowdoin and Topsham in Sagadahoc County; as scheelite disseminated in pegmatite in Washington County, and in York County. It is unlikely that any of these minerals will be found in commercial quantities.

FUTURE POSSIBILITIES

47. The mineral industry in Subregion "A" in the future will probably continue about as it has in the immediate past with the possible exceptions of the development of manganese deposits in Aroostook County and the pyrrhotite deposit in Piscataquis County. The output of clay, granite, limestone, sand and gravel, slate, peat, and pegmatite minerals will probably expand slightly. Any early production of the base metals, copper, lead, and zinc, does not appear probable from the presently known deposits. Discoveries of base metals in the Bathurst districts, New Brunswick, and reported strikes along a southwestward trend toward the International Boundary, have encouraged prospecting for similar deposits in eastern and northeastern Maine.

48. Diamond drilling now in progress (1954) by the U. S. Bureau of Mines of the asbestos deposits in Somerset County appears to be encouraging, but an accurate appraisal of the deposits cannot be made until the drilling is completed.

49. The large manganese deposits of Aroostook County represent one of the most important sources of low-grade ore in the United States. However, this low-grade ore cannot become economic in any sense until a process is developed that will recover a commercial grade concentrate. The lack of a nearby market and the cost of transportation to distant consumers, principally the steel manufacturers, are handicaps to the possible use of these deposits. Even in case of war, or other emergencies, these deposits are not likely to be developed until an effective method of concentration is devised.

50. Under favorable economic conditions, the Katahdin pyrites deposit may become an important producer of iron sinter and sulfur. However, unless the demand for sulfuric acid increases in the New England-New York region, or the Gulf coastal sulfur deposits become depleted, the development of the Katahdin pyrites deposit may be delayed. The major handicap to a commercial operation for the recovery of the large amounts of iron and sulfur in this ore is the profitable disposal of the sulfur, principally for the production of sulfuric acid. The costs of shipping this acid are high and the present local demand for it is small. Refined sulfur from producers using the Frasch process in the Gulf coastal regions can be delivered in Subregion "A" ports at prices below those of local producers using

pyrites deposits. Also, in the near future, sulfuric acid will probably be produced as a byproduct at base metal mines in New Brunswick and will be competing with the Gulf Coast sulfur.

MINERALS PLAN

51. Unlike most engineering projects, for which costs can be rather closely estimated, research and development in the mineral resources field cannot be forecast very far in advance. Any program must be adjusted to findings during the course of the work, and costs cannot be determined until the final objective is attained. Who can say how much it will cost or how long it will take to develop an economic process for using the low grade manganese-iron ores of Aroostook County? In routine geologic quadrangle mapping there is always the hope that something meriting detailed exploration will be found. Exploration on one deposit revealed by geologic mapping of a quadrangle may easily cost several times as much as the whole geologic map. Changing market conditions, technologic advances, and international political changes will affect all programs. In view of these considerations, the following recommendations should be considered as only the beginning of a program that will develop as it progresses.

52. The entire region should be mapped geologically on a scale of an inch to the mile, a program that will require several

hundred professional man years. Work should begin on a limited basis around areas such as the Aroostook County manganese deposits, and along the trends of the recent discoveries on the Canadian side of the border. Mapping should be accompanied by reconnaissance geochemical and geophysical surveys in potentially promising areas. Drilling, trenching, and test pitting will be needed to follow up the geochemical and geophysical work.

53. Metallurgical research on the manganese ores should be continued to develop a more economic recovery process.

54. Pegmatite investigations similar to those made by the U. S. Geological Survey in 1942-45 should be continued in a search for strategic minerals, such as mica, beryl, columbite-tantalite, and for feldspar.

55. Recent encouraging exploration for asbestos should be followed up.

56. Additional research on recovery and separation of pegmatite minerals, especially beryl, should be done.

57. The investigations of the possibilities of treating clays to improve their characteristics for various uses, for example as paper filler, should be resumed.

58. Detailed geologic investigation of each area to be flooded should precede construction of a dam, particularly within areas now covered only by reconnaissance mapping, in

view of the diversity and extent of mineral deposits that are known to occur in the region. This recommendation applies particularly to the Little Spencer Stream asbestos-bearing area whibh would be inundated by a dam at the Grand Falls site on the Kennebec River.

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7

SECTION XIII - INSECT CONTROL

1. This section provides information on the present status of insect-borne diseases, insect disease vectors, and pest insects in Subregion "A"; data to determine the need for and approximate cost of control programs; and benefits that may accrue from such control programs. Insects adverse to public health are considered in two categories: (a) those that are capable of carrying and transmitting disease micro-organisms, and (b) those that reduce the efficiency and comfort of man and affect his economic status.

PRESENT STATUS OF INSECTS ADVERSE TO PUBLIC HEALTH AND THEIR CONTROL

2. Disease and vector problem. - Despite the return of some war veterans who contracted malaria in malaria-infested areas and the presence of *Anopheles quadrimaculatus*, the malaria vector, the disease has probably never been endemic in the subregion. The mosquito which transmits malaria occurs in moderate numbers in the southwestern portion of the subregion. It breeds in debris, flotage and vegetation along the edges of permanent bodies of relatively fresh and clear water during the summer.

3. Eastern equine encephalitis is not presently considered a public health problem in the subregion. Only one recognized epidemic in man has occurred in the New England-New York area during the last 30 years, that being in 1938. This outbreak

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was centered in Massachusetts where 34 human cases were definitely identified. Although little positive information is available, there are several species of mosquitoes occurring in the subregion which may be implicated in the possible transmission of the disease. These include Aedes vexans, A. sollicitans, A. cantator, A. triseriatus, A. atropalpus, Mansonia perturbans and Culiseta melanura. One or more of these species is common in a wide variety of habitats during the spring, summer and fall.

4. Rocky Mountain spotted fever, a tick-borne disease, has not been reported within the subregion, although several cases of the disease have been contracted in nearby Massachusetts, principally on Cape Cod. This disease is not considered to be a public health problem at the present time. The vector, Dermacentor variabilis, has been reported from a triangular area with Red Hill and Sandwich, Freedom and Wolfeboro, New Hampshire, as the three corners of the triangle; in the vicinity of Conway, New Hampshire; as far north as Casco along the Maine coast; and in certain inland localities. One major infestation is around the village of Casco, Maine, extending southward to Sebago Lake and there is some evidence that ticks are spreading throughout the subregion. Ticks frequent grassy roadsides, paths and other areas inhabited by certain rodents, dogs and other mammals. The adult tick attacks man in the spring.

5. Tularemia occurs in the subregion but is not common in man and is not considered of public health importance at the present

time as an insect-borne disease. Tularemia is known to be endemic in wildlife and is rarely found in man. One case was contracted from wildlife near Kokadjo Lake. The disease is transmitted to some extent in other parts of the country by ticks, deer flies, and certain other biting insects but there are no records to indicate such transmission to man in this subregion. Many species of deer flies are common in this subregion, but none of these have been implicated in the transmission of tularemia.

IMPORTANT INSECT PESTS OF PUBLIC HEALTH IMPORTANCE AND THEIR CONTROL

6. ". . . Public Health has become something more than the absence of disease. Physical efficiency and comfort on which mental equanimity depends to a substantial degree, may be seriously disturbed by the continued annoyance of pestiferous mosquitoes which may or may not have disease transmitting potentialities." 1/ Many pestiferous insects within the subregion are known to occur in sufficient numbers to constitute a public health problem in that they reduce the physical efficiency and comfort of the individual. In addition to their annoyance, numerous cases of illness and incapacitation occur as the result of insect bites.

7. Aside from the purely public health aspect, insects affect the income of the subregion by reducing the recreational and resort season and the use of recreational facilities. It is esti-

1/ Release from Surgeon General, U. S. Public Health Service, October 12, 1950.

mated that a moderate increase in recreational income would generally result from carefully planned insect control measures. The actual cost necessary to obtain control is estimated to be only 5 percent of the added income accruing from the increased recreational activities. These estimates are based upon figures obtained in other parts of the country where insect problems are somewhat similar and where evaluations of benefits have been determined. Mere freedom from insect attacks and annoyance has not been expressed in monetary terms.

8. The pest insect problem. - A large number of collections and field studies indicate that mosquitoes, black flies, punkies, horseflies and deer flies are widely distributed and vary in importance. Therefore, it is impractical to describe each locality where a problem may exist.

9. With the exception of the ticks, all of the insects considered develop in water or very wet soil. The abundance of any species depends upon the availability of favorable habitat and the climatic condition during its development. In order to evaluate the need for various pest insect control measures, it is essential that the general characteristics, life cycle and habits of the insects be known. Since many of the insect species mentioned do not have common names, Latin names are given so that reference can be made to a standard text and the biology of the insect can be determined. With this information insect

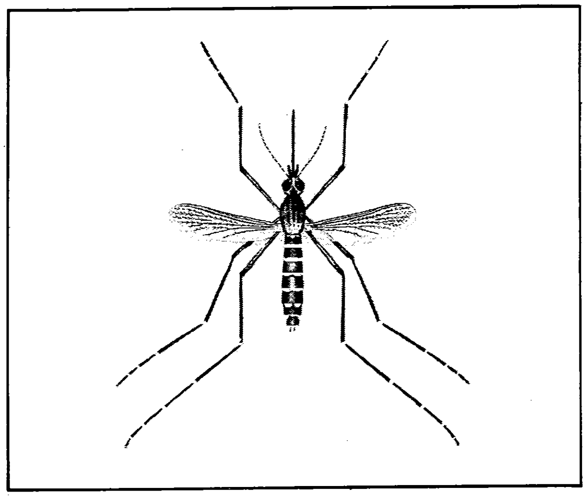
control measures can be directed against some habit or vital requirement of the insect.

10. Mosquitoes. - There are 33 species of mosquitoes known to occur in the subregion of which 23 are ordinarily troublesome as pests.

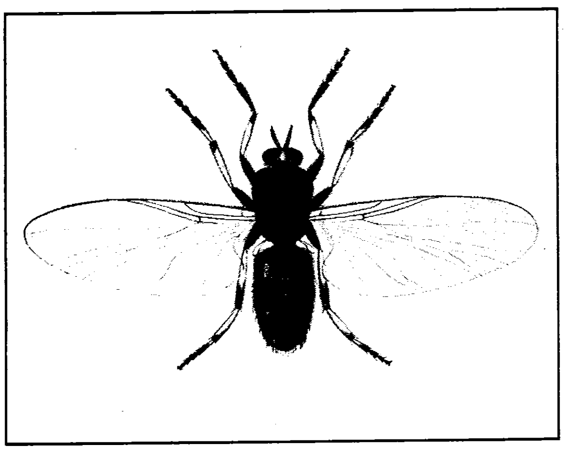
11. The salt marsh mosquito, *Aedes sollicitans*, is the most serious pest along the seacoast, developing in salt marshes flooded by spring tides. It appears periodically throughout the summer and seriously affects the well-being of residents and tourists at seaside resorts and those located within a few miles of salt marshes. In recent years, only three localized control projects in Maine (Cranberry Isle, Isleford; City of Old Orchard Beach; and Drakes Island, Wells) have been in operation. Ditches have been constructed in several marshes along the coast in years past, but these are now generally in need of repair and are non-functional. Salt marsh ditching with proper maintenance in the vicinity of urban and recreational areas has been shown to be effective along the northern Atlantic Coast and would materially improve the comfort and well-being of residents and tourists in localities where this species develops in abundance.

12. The brackish water mosquito, *Aedes cantator*, develops further inland in the bordering brackish pools and during certain years may exceed *A. sollicitans* in importance. In many instances where such pools cannot be drained, it may become necessary to control breeding by larviciding.

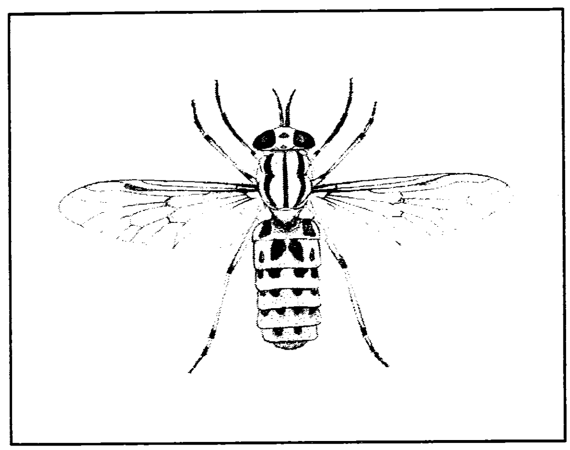
13. A number of species of Aedes mosquitoes may be differentiated from other members of the group by their ability to produce only one brood in the spring. These mosquitoes develop in temporary pools in forest and grassland areas and result in insect infestations of relatively short duration in woodland recreational and suburban areas. The principal species are *Aedes aurifer*, *A. communis*, *A. excrucians*, *A. fitchii*, *A. implacabilis*, *A. intrudens*, *A. punctor*, *A. stimulans*, and *A. trichurus*. Breeding areas favorable for development of these species exist over a considerable portion of the subregion. Ditching and filling are the most permanent control measures but are often impractical because of the large areas involved and because it is impossible to drain many low-lying areas. Larviciding along the edges of certain heavily productive pools in and adjacent to urban and recreational areas is often practical and effective. A few other species of *Aedes* mosquitoes develop either intermittently or continuously throughout the spring and summer. *Aedes canadensis* and *A. cinereus* are important pests in this category. Two additional species, *Aedes sticticus* and *A. vexans*, develop in large numbers in isolated pools after floods. *Aedes vexans* is the major pest of all these species, not only because it is capable of migrating three miles or more from its place of development but also because it develops in enormous numbers and has an unusually wide range of breeding places.



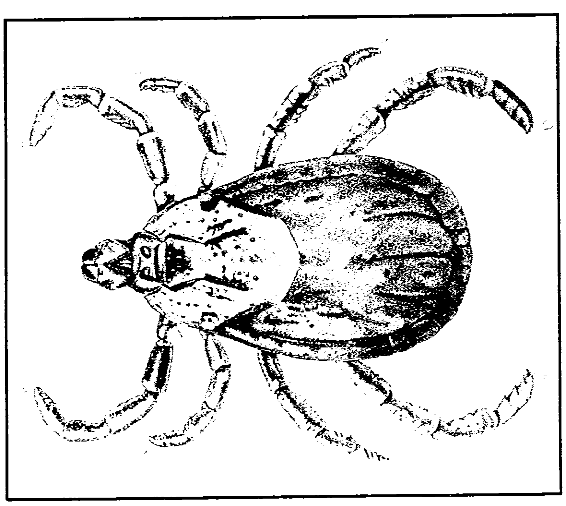
Mosquito. *Aedes vexans.*



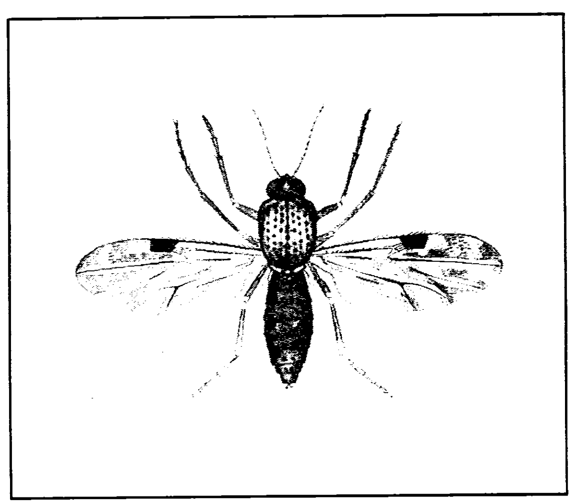
Blackfly. *Simulium venustum.*



Deer fly. *Chrysops discalis.*



American dog tick. *Dermacentor variabilis.*



Biting midge. *Culicoides furens.*
(Punky or No-see-um)

Pest insects, greatly magnified. Subregion "A".

14. The Northern House mosquito, Culex pipiens, is a severe urban pest throughout the summer, biting during the evening and night. It develops in water found in barrels, cans, fish pools, and street drains, and in slow-flowing streams and ponds polluted with garbage, sewage, and other filth. One breeding place may produce enough mosquitoes to seriously annoy an entire village. Control of this species is highly desirable in many urban areas and can be effectively accomplished only by a coordinated and carefully managed community effort.

15. Mansonia perturbans, is sometimes a bad pest locally during the summer and control is highly desirable when this species is plentiful. Because the larvae do not come to the surface of the water for air during their development, special, carefully timed and supervised control measures are required.

16. Black flies. - Three species, Prosimulium hirtipes, Simulium venustum, and S. tuberosum are the principal pests of this group, although about 14 species are known from the subregion. They develop principally in fast-flowing streams and exhibit a flight range of five to six miles. This group is a serious pest in late May and early June, in the northern half of the subregion. The bites from these insects have little or no effect upon some individuals. However, in most cases, the bite produces an itching and swelling which disappears in a few days. With others, several bites or repeated bites often cause serious illness. In addition, the presence of hundreds of flies swarming

about the head, whether biting or of non-biting species, is annoying.

17. Larviciding along streams for black fly control other than brief experimental trials has not been practiced but has been successfully and practically accomplished in the Town of Webb in New York, under conditions similar to those in this subregion. In the example cited above, DDT was applied aerially and after a second treatment, black flies were completely eliminated in seven of ten streams within the control area. Successful reduction of adult black flies resulted. Ground application of insecticides to streams at quarter-mile intervals has also been successful in certain black fly areas in other parts of the country. While the actual cost of insecticides is very low, the difficulty of applying larvicides to inaccessible streams is often great. Determination of the method and practicability of control measures must be based upon specific surveys.

18. Deer flies and horseflies. - Many species of deer flies and horseflies occur in the subregion. Several species of the genus *Chrysops* (deer flies) are pests during June, July, and August. They attack during the daytime, inflicting painful bites. Deer flies are solitary in habits and ordinarily not many attack at one time. They do not constitute a public health problem equal to that produced by the mosquitoes and black flies. The larvae develop sparingly in a wide variety of habitats and effective larvae control is not practiced in this subregion. Adults are shade-loving; therefore, clearing of shaded areas is of some value in preventing attacks.

19. The horsefly of public health significance is the green-head fly, *Tabanus nigrovittatus*. It develops in the salt marshes along the entire coast and has been noted to be especially bad at Small Point Beach, Harrington and in and around Georgetown, Maine, where a new State park is being developed. While no known control measures are being carried on in this subregion, success in relieving the problem has been reported at Ipswich, Massachusetts, by the establishment of a barrier zone treated with DDT on the marsh-land adjacent to the areas to be protected.

20. Ticks. - Two species of ticks attack man in the subregion, but only one, *Dermacentor variabilis*, the American dog tick, is important. On rare occasions, secondary infection or tick paralysis may result from their bites. Ticks are the most abhorred of all pests and occur principally during the spring. To date, control of the rodent hosts on which the immature ticks live has not been demonstrated as practical. The application of DDT along roadsides and paths to control adult ticks has been demonstrated as practical and effective in Massachusetts, Rhode Island, and Long Island, New York. Experimental adulticiding for ticks was demonstrated to be effective in the infested area near Casco, Maine, and near Sandwich, New Hampshire. The control of ticks is highly desirable when they occur in urban, recreational or other types of inhabited areas.

21. Punkies. - Punkies, ("nosee-ums" or sand flies) principally *Culicoides obsoletus*, are bad pests during late spring and early summer and bite predominantly in late afternoon. In heavily in-

fested areas they appear by the hundreds and in these densities create a public health problem. Little is known about the habitat in which they develop, and no control measures in the subregion are known.

22. Insect season. - The active insect season is approximately 100 days in northern reaches of the subregion and extends to 180 days along the coast. Black flies first appear in April or early May and attack fiercely in some localities near fast-flowing streams. During May, the black fly infestation subsides and the early spring *Aedes* mosquitoes replace the black flies as pests. When the early spring *Aedes* mosquito populations begin to subside in June and early July, the salt marsh mosquitoes and Northern House mosquitoes reach pestiferous proportions and remain abundant until frost. Ticks are common during late April, May, and early June.

BENEFITS AND COSTS OF INSECT CONTROL

23. The annoyance and discomfort produced by biting insects in this subregion vary from season to season and from year to year. This complicates any effort to evaluate the relief secured through insect control on a monetary basis. It is highly improbable that accurate data could be obtained on medical expenses and man-hours of work lost as a result of insect attacks. It would also be difficult to assign monetary values to benefits derived from the mere freedom from insect attacks by the inhabitants and workers where no actual medical expense or work loss is involved, although these

benefits are probably the most important. For these reasons, public health insect control benefits are generally classified as intangible.

24. A partial evaluation of tangible benefits can be made by a measurement of the effects of insect annoyance upon the income from recreational business. Insect attacks affect recreational income by reducing the length of the tourist season and the use of the recreational facilities. Replies received from resort operators, State park superintendents, and residents to inquiries made by entomologists and studies made in other localities, indicate that an increase in tourist patronage may be expected after some measure of insect control has been achieved and information about the improved conditions has been publicized.

25. The estimated annual average cost for temporary pest insect control in camps and resorts is \$300-\$500 per unit over a period of years. The average annual cost for control of pest insects in Subregion "A", where organized community projects may be carried on, is estimated to be \$162,000. The approximate resident population which would benefit from these control programs is estimated to be about 400,000.

26. The magnitude of public health insect problems and the feasibility of their control is not determined solely by the number of insects present in a given area but it is also related to the number of people affected and to the type and extent of

the control measures involved. In this subregion, the expenditure of funds for insect control appears feasible in the coastal and southern portions as the pest problems are within these areas. Most urban and recreational areas would benefit and in many instances, are benefiting by insect control which enhances the general well-being of the people and recreational attractiveness of the subregion.

INFLUENCE OF IMPOUNDMENTS ON PUBLIC HEALTH INSECTS AND THEIR CONTROL

27. Nearly every species of insects of public health importance in the subregion, except ticks, develop in water. Studies in various parts of the United States have shown that additional insect problems may arise as the result of habitat alterations resulting from development of water resources and that, in large measure, they can be minimized or even prevented if specific consideration is given to them during the planning and construction phases of the projects. In this subregion, however, extensive watered areas are already present so that total overall increases in insect populations as a whole resulting from the creation of additional watered areas are of little significance. However, a major factor to be considered in the development of additional watered areas is the effects of increased insect populations on the immediate vicinity where concentrations of human populations and recreational areas frequently become centered.

28. In general, the impoundment sites considered will not result in a pronounced increase in insects of public health importance if embayments capable of developing dense aquatic growth are minimized. A reduction of insect populations may be expected by impoundment construction because of inundation of marshes, bogs, and swamps and the creation of steep, rocky shorelines. Entomological surveys should be conducted at each site when the actual plans for a specific development are formulated in order that provisions for an adequate control program can be made.

29. Impoundments for wildlife habitat. - Wildlife areas of a type favorable for insect production, such as the shallow water impoundments described in Section IX, should be located preferably more than three miles from recreational areas, and urban and suburban developments, as the flight range of practically all insects of public health importance in this area is generally not more than three miles. Along the coast, the minimum distance should be five miles because the salt marsh mosquito is known to fly five miles or more from its breeding habitat. If shallow water impoundments are planned closer than the recommended distances and a potential insect hazard is found inherent in the development of the project, the developing agency and the appropriate public agency engaged in insect control should insure the carrying out of required insect control measures. Provision should be made in the plans for evaluation, prevention and control of insect problems associated with each project. It has been found

that in some areas the construction of impoundments for wildlife habitat has resulted in increased mosquito breeding. In these areas, trees, brush and debris inundated by the impoundment were not removed and their accumulation along the shore resulted in ideal conditions for mosquito breeding by creating an insect shelter of growing plants similar to that found in a swamp during the spring.

30. Farm ponds. - The development of farm ponds, where consideration has been given to insect production potential will not increase the public health nuisance problem. It has been found that insect production can be minimized if appropriate measures are included in the planning of farm ponds. Measures which have proven affective are as follows: stocking of ponds with fish, elimination of shallow portions, removal of woody vegetation, fertilization of the pond to increase plankton, and occasional drainage.

EFFECT OF INSECTS ON RECREATIONAL DEVELOPMENTS

31. A reduction in the use of recreational facilities frequently occurs because of the nuisance produced by biting insects. Because pest insects are prevalent within the subregion, all areas selected for recreational development will be subject to their attacks. Therefore, in the planning for the improvement and expansion of existing recreational facilities, and the acquisition in the future of new areas as described in Section X, it is necessary to consider the magnitude of the insect

pest problem, and to include in the recreational plans an adequate insect control program. When new areas have been selected for recreational development, an entomologist should survey each area and outline an adequate control program.

EXISTING LEGISLATION AND CONTROL PROJECTS

32. The Maine Department of Health and Welfare is authorized by law to make studies of mosquitoes and to make mosquito surveys in cooperation with the State entomologist and to take steps to prevent and/or control mosquitoes. Control measures may be initiated when money is appropriated for that purpose. Authority to trespass in connection with this work is authorized. There are no laws which specifically cover other insects of public health importance. The State conducts no actual control operations; however, it does provide advice and guidance for community control projects.

33. In New Hampshire, the Department of Agriculture; the Division of Insect and Plant Disease Suppression and Control; the Agricultural Experiment Station; and the State Department of Health can make mosquito studies. The Commissioner of Agriculture may undertake the suppression or control of serious insect pests and may establish rules and regulations and may employ measures deemed necessary. Cities and towns or private property owners may be required to take measures to combat insect pests. There are no laws which apply specifically to control of insects of public health importance and there are no State-administered control projects. No control projects are in operation in New Hampshire within the bounds

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of this subregion.

CONCLUSIONS

34. It is concluded that:

a. Vector-borne diseases do not constitute a public health problem at this time although vectors of several human diseases are present.

b. Of the many pest insect groups in the subregion, the mosquitoes constitute the principal pest problem, followed by black flies in importance. Other pest insects are generally of borderline public health significance but occasionally reach densities which constitute a serious pest problem. With the exception of ticks, all groups of pest insects reach densities which constitute a problem in rural camps and resorts.

c. The annual cost of controlling pest insects where organized community projects may be carried on is estimated to be about $162,000 for the entire subregion. The annual cost of insect control in camps and resorts is estimated to be $300-$500 per unit.

d. The benefits to be derived from pest insect control are primarily intangible. However, it is estimated that an increase in recreational income could be expected as the result of pest insect control at resorts and camps.

e. Entomological surveys should be conducted at proposed water resource and recreational sites when definite plans are formulated. Where insect control measures are necessary, they should be included as an integral part of the development and operation of the facility. At waterfowl developments, insect control programs should be instituted where necessary to provide adequate control with minimum adverse effect upon the fish and wildlife resources.

INSECT CONTROL PLAN

35. The plan for the control of insects adverse to public health utilizes three basic approaches--research, dissemination of information and direct assistance, and is as follows:

a. The continuance of biological studies and investigation and control programs, especially of black flies, deer flies, and punkies.

b. The maintenance of limited entomological surveillance periodically at certain developments to determine the effects of the project on insect populations.

c. Provision during the planning, construction and operation of wildlife impoundments and farm ponds for protective and control measures against vector and pest insects when such developments would be within three miles (five miles in salt marsh areas) of existing or anticipated centers of population or recreational areas. Where potential insect hazards are found inherent in the development of a proposed project, those concerned should: (1) determine appropriate measures for the prevention or control of such hazards and (2) carry out the required measures in the plan.

d. Assistance in the selection and planning of adequate insect control measures to permit maximum utilization of existing and proposed recreational developments. This would include coor-

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dinating the insect control program with wildlife programs in order that control could be effectively instituted with minimum adverse effect on wildlife.

e. Surveillance by entomologists, periodically at recreational developments and impoundments to determine the effects of their operation and maintenance on insect densities and to determine when additional insect control may be necessary.

f. Control of mosquitoes and green head flies in the major urban areas at an estimated annual cost of $162,000 and control in camps and resorts, at an estimated annual cost of $300 to $500 per camp or resort.

SECTION XIV - COORDINATED PLAN

GENERAL DISCUSSION

1. Subregion "A" is that portion of the New England-New York Region lying to the north and east of the Merrimack, Connecticut and Piscataqua River Basins. The total area of the subregion is about 34,000 square miles which is approximately one-half the area of the New England States. The subregion includes the State of Maine with the exception of 247 square miles along the southwestern boundary, which is in the Piscataqua River Basin; and 1600 square miles of eastern New Hampshire in the headwaters of the Saco and Androscoggin River Basins. Manufacturing, the subregion's most important economic activity, is concentrated in a relatively small number of industries. The five major industries are paper and allied products, textile mill products, leather and leather products, food and kindred products, and lumber and wood products. Recreational use of the resources is heavy throughout much of the subregion and agriculture is important, especially in the Aroostook area.

2. The control of pollution, measures to meet growing recreational demands and further development of hydro-electric power are the principal needs of the subregion. For the continued healthy growth of the subregion's economy measures are also needed for the preservation and development of the fish and wildlife, agricultural and mineral resources. Development and management needs for the subregion's resources are set forth in the following paragraphs.

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3. Storage and stream flow regulation. - Major water storage amounts to about 4,900,000 acre-feet. Most of this storage is used to regulate stream flow for power purposes and log driving but some of it is maintained for public water supply, recreation and other uses. Additional storage is needed throughout the subregion to improve characteristics of stream flow, especially during periods of low stream flow. The daily discharge of the rivers is being measured at 52 stream gaging stations which have provided sufficient data for general studies. Additional stations are needed on ungaged rivers of importance and on a number of representative small streams.

4. Water supply. - In general, a large surplus of surface water will be available for water supply in Subregion "A" for the next 50 years. The quality of the surface waters are generally suitable for domestic, agricultural and industrial uses. The future quality of the surface waters will depend on the action taken to maintain or improve the present water condition by control of municipal and industrial pollution. Ground water is available from bed rock or unconsolidated deposits throughout most of the subregion, though in some rural areas water supplies may be inadequately developed. The use of water for supplemental irrigation, although not significant at present may become important in the future. Trends in this type of water use should be observed so that orderly adjustments may be made if supplemental irrigation begins to compete with other water uses.

5. Pollution control. - One of the pressing needs of the subregion is for control of the pollution of the waters in river basins and the coastal area. While the use of water bodies as the final means of disposal for waterborne wastes is indispensable, the discharge of large volumes of untreated sewage and industrial process wastes has resulted in serious deterioration of the quality of receiving waters. It is the use of the streams for disposal of wastes which is most in conflict with desirable water uses, especially recreation, shellfish operations, industrial water supply and, in some instances, public and agricultural water supply. Some progress has been made as to ways and means by which pollution may be controlled but additional personnel and funds are needed to carry out the studies and investigations required for the solution of stream pollution and waste treatment problems. Statutory stream classifications have not been adopted for any waters receiving significant amounts of pollution in Maine; however, some non-polluted waters have been designated as Class A.

6. Flood control and drainage. - Subregion "A" is generally forested and contains extensive areas of lakes, ponds and swamps which tend to retard run-off in the event of heavy rains. Occasional flash floods occur on tributaries but usually these have little effect on flows in the main streams. The construction of flood control reservoirs was considered in rivers where total damages indicated a possibility of feasibility, and local protection works such as dikes and channel improvement were studied at the more

seriously affected damage centers. It was found that the benefits which could be obtained by these flood control measures were not sufficient in any instance to justify the cost at this time.

7. Power development. - Subregion "A" possesses a potential water power aggregating about 1,700,000 kilowatts of which some 450,000 kilowatts have been developed, leaving about 1,236,000 kilowatts as the undeveloped hydroelectric potential including redevelopment of existing projects. Of the 450,000 kilowatts already developed approximately 277,000 kilowatts or 62 percent are accounted for by 60 utility installations. The remainder of the existing water power developments comprises about 175,000 kilowatts of capacity in 55 stations operated by nonutility enterprises. It is estimated that by the year 1975 the subregion will need about 225,000 kilowatts of capacity in addition to that which will be available from existing and presently scheduled installations. Increased needs for power in the subregion could be met by projects included in the inventory power plan.

8. Navigation and beach erosion. - The principal needs for navigation in Subregion "A" are for completion of authorized improvements of rivers, harbors and channels, of which the anchorage at Portland, Maine is the most urgent. Studies are needed at 19 locations where improvements are desired. Problems of beach erosion are a matter of much less concern due to the rocky and rugged character of the greater part of the coastline of the subregion. Further beach erosion control studies and additional information concerning shore protective structures are needed for the sandy

stretches of beach between Portland and the Piscataqua River, where there are erosion problems.

9. Fish and wildlife. - The increases and improvements in commerce, industry and agriculture which have resulted in greater leisure time for the enjoyment of fish and wildlife resources, have also created many problems in their management. A need exists for protection from pollution of the clean waters throughout the subregion, abatement of existing pollution on the main rivers and coordination of existing and future water development projects with fish and wildlife requirements. The wildlife problem is mainly one of maintaining or increasing wildlife populations and preserving the natural forested habitat that exists in the subregion.

10. Recreation.- The resources adaptable to outdoor recreation within the subregion are so varied and extensive as to make it unusually important in this field. The non-urban recreation facilities are however insufficient to meet current needs and with the growth of population and the steady increase of tourist visitation, these needs will become greater. Additional facilities are needed in recreation areas in public ownership. There is also a need for the establishment and development of additional public recreation areas, both inland and along the seacoast and for the preservation of representative portions of the wilderness, for which the subregion has long been noted. An expanded system of highway wayside areas and scenic overlooks along routes of travel

and the development of the present system of historic sites and memorials to their maximum as educational and inspirational exhibits are other needs. Pollution abatement and insect control are necessary adjuncts to some of these developments.

11. Land management. - Land management measures are needed in the subregion to conserve and improve farm and forest land to meet increased future demands for food and fiber products. Included in the measures are land use adjustments, improvements to crop and pasture land to conserve soil and moisture, and improvement of forests for conservation, ground cover and yield. In the Kennebec and Penobscot River Basins and in the coastal area, there are several large areas of wetland in which individual and group drainage projects are needed on farmland. There is a need for additional facilitating measures designed to assist individual farmers and forest landowners in installing the necessary conservation and improvement measures.

12. Minerals. - Present operations in connection with the production of mineral raw materials in Subregion "A" are mainly concerned with nonmetallic materials such as sand and gravel, stone, clay, limestone and pegmatite minerals. Few, if any, metallic minerals are produced in the subregion. The discovery of an economic process of beneficiation will stimulate the development of the potentially important manganese deposits of Aroostook County, Maine. The large Katahdin pyrrhotite deposit is held awaiting an expected demand for the sulphur of pyrites deposits. Detailed geologic maps

necessary for effective exploration and prospecting are available for only a few small areas in the subregion. Topographic mapping of the subregion should be continued and completed. The discovery of major deposits of copper, lead and zinc in New Brunswick, Canada along the regional trend of similar geologic structures in Maine emphasizes the need for more geologic investigations. A systematic program of geologic mapping, and geochemical and geophysical surveys is needed throughout the subregion.

13. Insect control. - Insects adverse to public health are considered in two categories: those that are capable of carrying and transmitting disease micro-organisms and those that reduce the efficiency and comfort of man and affect his economic status. Records indicate that vector-borne diseases do not constitute a public health problem in Subregion "A" at the present time. Many pestiferous insects within the subregion are known to occur in sufficient numbers to constitute a public health problem in that they reduce the physical efficiency and comfort of the individual. There is need for further study and research concerning control of insects adverse to public health, such as black flies, punkies and deer flies. Control measures are necessary to reduce the densities of pest insects, especially of mosquitoes in urban areas and at camps and resorts.

VIEWS OF LOCAL INTERESTS

14. A public hearing was held in Augusta, Maine on June 12, 1952 to afford local interests an opportunity to express their views with reference to procedures and objectives of the regional survey and to bring to the attention of the Committee any resource problems which the Committee should consider during the course of the survey. Those who appeared in response to the Committee's invitation generally favored State and local participation in matters dealing with resources and were of the opinion that Federal participation should be limited to the fields of planning and research.

14a. When the survey was nearing completion and tentative findings of the Committee had been drafted, additional public hearings were held in order that the Committee might obtain the views of interested parties on the tentative findings. Public hearings on the matters covered by this chapter and other chapters on the river basins of Subregion "A" were held at Berlin, New Hampshire on November 10, 1954, and at Augusta, Maine, on November 11, 1954.

14b. A representative of a fish and wildlife group requested that the affects of hydroelectric power projects on fish and wildlife be included in the discussion of coordinated basin plans, and that specific measures to adjust conflicts be stated. A representative of the Maine Development Commission suggested that discussions of the economics of hydroelectric power projects indicate that future conditions may decrease, as well as increase, the value of projects. The Maine Department of Inland Fisheries and Game suggested that there be continuing coordination among the resource interests, and that the survey data be kept up-to-date in future years.

14c. Additional views, pertinent specifically to the Androscoggin and Saco River Basins are summarized in the Chapters dealing with those basins. The views expressed by those who appeared and the views expressed in written statements have been considered by the Committee in the preparation of the report.

FEATURES OF THE COORDINATED PLAN

15. Upon the basis of the inventory of the land, water and related resources of Subregion "A" and the measures required for their conservation, development, and utilization, a Coordinated Plan is presented below. The several measures are summarized in Sections III to XIII, inclusive of this chapter and are set forth in detail in Chapters III to X inclusive. The principal features of the Coordinated Plan are as follows:

a. Storage and stream flow regulation.

(1) Installation of additional stream gaging stations on ungaged rivers of importance and on a number of representative small streams. Estimated cost $33,000.

Five storage reservoirs and thirteen power and storage projects included with the power development features of the Coordinated Plan as described in sub-paragraph e, would furnish 4,400,000 acre-feet of additional storage for stream flow regulation.

b. Water supply.

(1) Investigations of the occurrence, general availability, quantity and quality of ground water resources to aid in determining the best method for developing dependable ground water supplies. Estimated cost, $435,000.

(2) Initiation of a study of the trends in demand for water used for supplemental irrigation. Estimated annual cost $6,500.

c. Pollution.

Installation of facilities for treatment or disposal of municipal, industrial and private wastes. In the absence of stream classifications established by the State Legislatures of Maine and New Hampshire which are required in definitive plans for the control of pollution, a provisional plan as described in Section V of this chapter is offered as one of several possible plans to serve as a guide or frame of reference in planning water resources development. Estimated total first cost $40,846,000. The provisional plan is summarized below:

(1) Municipal sewage disposal facilities consisting of: secondary and primary sewage treatment facilities; offshore outfall sewers; connection to municipal sewage system for sources of pollution; subsurface disposal systems; additions to existing plants and chlorination facilities. Estimated first cost $27,480,000.

(2) Industrial waste treatment or disposal facilities at manufacturing plants. Estimated first cost $12,335,000.

(3) Individual private sewerage installations including subsurface disposal systems and connections to municipal systems. Estimated first cost $1,031,000.

d. Flood control and drainage.

(1) No projects specifically for flood control or drainage. Some reduction in peak runoff could be expected from the land treatment features of the Coordinated Plan.

(2) Improvement of the warning service to give timely notice of flood threats. No estimate of cost of this feature has been made.

e. Power development.

(1) Forty-one hydroelectric power and storage projects as summarized in Table 45. The projects would provide 1,174,900 kilowatts of installed capacity and additional usable storage of 4,422,270 acre-feet without redevelopment of existing downstream projects.

Table 45 - Summary of power and storage projects, Subregion "A"

Basin or area	Usable storage (acre-feet)	Installed capacity (kilowatts)	Annual generation (1000 kwh) 2/	First cost
Saint John	2,299,000	255,500	1,002,400	$ 87,330,000
Penobscot	1,348,500	309,500 1/	1,611,850 1/	221,175,000 4/
Kennebec	317,070	461,000 3/	1,387,740 3/	171,198,000
Androscoggin	182,700	92,500	462,010	52,976,000
Saco	275,000	52,400	145,480	34,114,000
Maine Coastal	-	4,000	10,200	2,449,000
Totals	4,422,270	1,174,900	4,619,680	$569,242,000

1/ Includes Ripogenus project currently under construction (36,000 kw-250,000,000 kwh), not in basin plan.

2/ Includes increase at existing plants without redevelopment.

3/ Not adjusted for loss of existing installation at Madison.

4/ Does not include Ripogenus project.

f. Navigation.

(1) Improvements at Portland Harbor including removal of ledge rock of Portland Head Light, dredging of House Island anchorage to a depth of 35 feet, and removal of hard

shoal in 35-foot channel. Estimated cost, $1,222,500. Work on the dredging and anchorage is scheduled to be initiated in 1955.

(2) Ten-foot anchorage at Beal's Harbor; 6-foot channel between Isle au Haut and Kimball Island; ledge removal in 9-foot entrance channel at Hendricks Harbor; 6-foot basin and 3 ice breakers at Wood Island Harbor and Biddeford Pool; and extension of existing breakwater 90 feet and construction of 385-foot breakwater at Lubec Channel; 8-foot channel and 6-foot channel and anchorage at Scarboro River.

(3) Complete authorized studies at 19 locations. Estimated cost $54,000.

g. <u>Fish and wildlife.</u>

(1) Protection from pollution of waters presently unpolluted and abatement of existing pollution, including shellfish areas.

(2) Removal of small dams or inclusion of fishways in dams or other barriers to the migration of desirable fish species.

(3) Research and management of fish and wildlife at existing and contemplated water development projects.

(4) Application of control techniques to limit abundance and spread of undesirable fish species.

(5) Establishment of better and more widespread coordination between the timber operations of owners of large tracts of land and the application of conservation practices for wildlife.

Special reference is made to the problem of timber cutting on important deer-wintering areas.

(6) Arrangement for public use of existing roads and construction of new roads into the heavily forested areas.

(7) Additional forest-fire patrol teams to police the wilderness areas during hunting seasons.

(8) Continued research into the problems of the deer resource, with an aggressive program of law enforcement against poaching and predation by dogs.

(9) Development of fringe areas around farmlands to retain transitional vegetative cover for small game animals rather than open land or forest.

(10) Development of marsh areas for waterfowl and fur bearers, wherever feasible.

(11) Installation of a program of anadromous fish restoration with emphasis on research and new methods of financing fishway construction and dam removal operations.

No estimate of the cost of the fish and wildlife features of the Coordinated Plan has been made.

h. Recreation.

(1) Further development of established park and recreation areas, including their enlargement where feasible, with particular emphasis on water recreation and tent and trailer camping.

(2) Establishment of 13 major recreation areas inland utilizing outstanding lake and mountain features.

(3) Establishment of 5 seashore recreation areas to provide a minimum of 15 miles of coastline and sandy beaches in public ownership, with adequate shore lands and supporting background features for recreation use.

(4) Expansion of existing highway wayside areas and development of additional sites throughout the sub-region.

(5) Preservation of wilderness conditions in the Allagash River, in portions of the upper Kennebec and Penobscot Rivers, and in the Grand Lakes portion of the St. Croix River Basin.

(6) Establishment of camping areas at strategic points along the coast, in the White Mountains, and in the wilderness lake country.

(7) Full development of the present system of historic memorials as educational features and tourist attractions.

(8) Continued study of historic sites with a view to rounding out the present system of memorials.

(9) Archeological excavation and exploration at the sites of historic Indian villages and early French and English settlements, the finds to be displayed by modern museum methods.

(10) Coordination of expanded and new recreational developments with programs for pollution abatement and pest insect control.

Estimated total first costs of the recreational features of the Coordinated Plan are given in Table 6.

Table 46 - Summary of first costs for recreation developments, Subregion "A"

Basin or area	First cost
Saint John	$ 5,970,000
St. Croix	1,309,550
Penobscot	4,055,000
Kennebec	5,729,500
Androscoggin	3,623,000
Presumpscot	861,500
Saco	1,598,000
Maine Coastal	12,565,000
Total for Subregion "A"	$35,711,550

i. Land management.

(1) Land use adjustments: changing land from present uses to other and sounder uses.

(2) Capital improvements to crop and pasture land: including erosion control, land clearing, fencing, seeding to permanent pasture, drainage and farm ponds.

(3) Periodic practices for crop and pasture land: including fertilizing hay, pasture and cultivated crops.

(4) Forestry measures: including tree planting, timber stand improvement, forest development roads, other measures.

(5) Facilitating measures for crop and pasture land and for forest land: including educational assistance, technical services, resource surveys and plans, line surveys and maps, aerial photographs and maps, and acquisition of land for forestry purposes.

Estimated first cost of the land management features of the Coordinated Plan is given in Table 47.

Table 47 - Summary of first cost for land management measures, Subregion "A"

Basin or area	First cost
Saint John	$12,037,100
St. Croix	- a/
Penobscot	11,266,000
Kennebec	11,868,200
Androscoggin	8,799,400
Presumpscot	- a/
Saco	- a/
Maine Coastal	14,532,200
Total for Subregion "A"	$58,502,900

a/ Included in cost for Maine Coastal Area.

j. Minerals.

(1) Completion of topographic mapping of the subregion.

(2) Aerial and ground geophysical and geochemical surveys prior to selective geologic quadrangle mapping.

(3) Continuation of metallurgical research on the manganese ores to develop an economic recovery process.

(4) Continuation of pegmatite investigations in a search for strategic minerals.

(5) Additional investigations of the encouraging asbestos indications.

(6) Continuation of investigations of the beneficiation of clays to improve their characteristics for various uses.

(7) Detailed geologic investigation of areas to be inundated preceding dam construction, particularly within areas now covered only by reconnaissance mapping.

No estimate of the cost of the minerals features of the Coordinated Plan for this subregion has been made.

k. Insect control.

(1) Continuation of biological studies and investigations and control programs, especially of black flies, deer flies, and punkies.

(2) Maintenance of limited entomological surveillance periodically at certain developments to determine the effects of the projects on insect population.

(3) Provision during planning, construction and operation of wildlife impoundments and farm ponds for protective and control measures against vector and pest insects when such developments would be within three miles (five miles in salt marsh areas) of existing or anticipated centers of population or recreation areas.

(4) Assistance in the selection and planning of adequate insect control measures to permit maximum utilization of existing and proposed recreational developments.

(5) Control measures in urban areas.

(6) Control measures in rural camps and resorts.

The estimated cost of the insect control features of the Coordinated Plan is given in Table 48.

Table 48 - Summary of costs for insect control, Subregion "A"

Basin or area	Cost of community protection	Cost per camp or resort unit
Saint John	$ 16,900	$500
St. Croix	2,500	400
Penobscot	9,500	500
Kennebec	11,200	500
Androscoggin	9,900	500
Presumpscot	27,000	300
Saco	20,000	400
Maine Coastal	65,000	400
Total	$162,000	

APPRAISAL OF THE COORDINATED PLAN

16. The appraisal of the Coordinated Plan is influenced by the fact that the plan is offered as an inventory of possibilities rather than as a definite program for implementation in accordance with a specified time schedule. Monetary values have been assigned to benefits which can be identified and measured. Intangible benefits are described.

17. Cost estimates are based on 1949 prices and annual charges include amortization, interest, maintenance and operation. The amortization period is taken as the anticipated useful life of structures or the average tenure of landowners. In general, the interest rate is taken at $2\frac{1}{2}$ percent for public works and 4 percent for private works. The annual costs of features of the plan which are of a private nature are based on private financing, while the costs of features that would normally be provided by municipal, State or Federal agencies are based on public financing. The estimate of annual charges for the power features of the plan are based on the use of private capital with an average rate of return of $5\frac{1}{2}$ percent of the first cost of the project plus estimated interest charges which would accrue during the construction period.

18. Storage and stream flow regulation. - New conservation storage of about 4,400,000 acre-feet which is incidental to the hydroelectric power features of the plan would provide improved stream flow regulation and increased industrial and hydroelectric

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power and other conservation benefits. Costs and benefits are discussed below under power development. Additional stream gaging stations would supply information on the yield of small streams needed especially for the study of water supplies for small communities and for irrigation. The information is also needed in designing highway culverts and bridges. The estimated first cost of the gaging stations is $33,000.

19. Water supply. - The benefits from the water supply investigations included in the Coordinated Plan are intangible. The study of supplemental irrigation would give warning when this use threatens to infringe upon other water uses. The ground water investigations would outline source areas favorable for the development of both large and small water supplies. The information thus obtained would also serve as an aid in determining the best methods for the development of dependable ground water supplies.

20. Pollution control. - The pollution control features of the Coordinated Plan would improve the water quality of the polluted reaches of the streams and tidal areas. Pollution control would improve almost all water uses of the rivers and streams, particularly fishing and recreation, improve and protect the coastal shellfish resources and reduce the chance of waterborne diseases. The benefits of pollution control have not been assigned a monetary value. The estimated first costs of pollution control measures are $40,846,000 and the estimated annual charges are $4,595,350.

21. <u>Power development</u>. - The power developments in the Coordinated Plan would provide an increase in hydroelectric power capacity of 1,174,900 1/ kilowatts with average annual energy output of 4,619,680,000 1/ kilowatt hours for industries and utilities (including the increase of energy at existing plants resulting from regulated flow). The estimated annual value of the power from the new projects would be $47,331,700. This value is based on the cost of generating equivalent power by means of privately financed steam plants in the subregion as the most likely alternative source in the absence of the hydroelectric projects. The total cost of new developments is estimated at $569,242,000. Annual charges are estimated at $62,711,300 based on private financing. The benefit-cost ratio is 0.75 to 1. In addition, the storage included in the plans for the Kennebec and Penobscot River Basins would provide average annual flood control benefits of $46,400.

22. <u>Navigation</u>. - The navigation features of the Coordinated Plan would increase the utility of and reduce hazards at many harbors, channels, and anchorages for commercial and pleasure craft. Especially important in this regard is Portland Harbor, which is the largest port area northeast of Boston in the United States. The total cost of the seven projects in the plan is estimated to be 1,744,700 ~~$1,659,700~~ and the total annual cost $87,700. Benefits from all projects except Beal's Harbor, Scarboro River, Woods Island Harbor, and Lubec Channel are not susceptible of monetary

1/ Includes Ripogenus project under construction (36,000 kw and 250 million kwh) not in plan.

evaluations. The combined annual costs for the Beal's Harbor, Scarboro River, Woods Island Harbor, and Lubec Channel projects are $24,300 and the combined annual benefits are $79,700. The benefit-cost ratio for these four projects is 3.3 to 1. For the remainder of the projects there are intangible benefits which would include greater navigational safety, increased convenience, increased working time, refuge from storms, and increased recreational and fishing use. The suggested studies would determine the economic feasibility of obtaining desired improvements at 19 locations.

23. Fish and wildlife. - The fish and wildlife features of the Coordinated Plan would provide for correction of existing abuses and deficiencies of the fish and wildlife resources of Subregion "A". The improved conditions would conserve the resources and would attract to the subregion additional sportsmen, whose expenditures would add to the income of the residents. The costs have not been estimated and the benefits have not been assigned monetary values.

24. Recreation. - Both tangible and intangible benefits would result from further development of the resources along the lines of the recreational features of the Coordinated Plan. Tangible benefits would be represented in part by monetary expenditures of visitors using the recreation resources, areas and facilities. The benefits attributable to the plan are estimated to be about 10 percent of the estimated increase in gross annual expenditures or about $5,140,000. Annual charges are estimated at $3,086,500 giving a benefit-cost ratio of 1.66 to 1.

25. The intangible benefits of the recreation features of the plan would be very large because of the great number of persons benefited. Benefits consist of such values as refreshment of physical and mental well-being, relaxation from care and enjoyment of communion with nature. Though not measurable in monetary terms, these intangible benefits are the real objectives of the recreation features of the plan.

26. Land management. - The plan would provide measures to meet expanding needs for food and fiber; provide for the conservation and improvement of soil and forest resources; and for the conservation of water and the reduction of peak runoff. The major benefits from conserving and improving crop and pasture lands are susceptible of monetary evaluation. Increased crop and forage production, reduction of soil erosion and of flood water damage would amount to annual benefits of $9,274,400. These measures would cost annually about $8,304,400, showing a benefit-cost ratio of 1.12 to 1. Benefits not evaluated in monetary terms are fire protection, water supply for irrigation and spraying from farm pond development, reduction of sedimentation and the enhancement of wildlife values.

27. Tree planting, timber stand improvement, development of forest roads and other measures on forest land would cost annually about $2,319,800. The annual benefits from these measures would amount to about $3,874,113, giving a benefit-cost ratio of 1.67 to 1.

28. <u>Minerals</u>. - The minerals features of the Coordinated Plan would complete quadrangle topographic and geologic mapping and might indicate the location of mineral deposits of commercial value. The costs have not been estimated. The benefits are not capable of monetary evaluation but the results would be of assistance to engineers, contractors, miners and prospectors and might result in the establishment of profitable new industries.

29. <u>Insect control</u>. - The insect control features of the Coordinated Plan would make it possible for camps, resorts and communities to control insect pests and disease vectors. While the benefits are not capable of monetary evaluation, the measures would make life more comfortable for residents and visitors. The recreation industry would probably be benefited by an increase in the number of vacationists.

RECOMMENDATION

30. The Committee recommends that the Coordinated Plan, as heretofore described, serve as a guide for the development, conservation and use of the land, water and related resources of Subregion "A".